**Hydrogen Fuel Cell and Battery Electric Vehicle Stakeholder Charrette**

Expanding Hawaii's Clean Transportation Solutions

**Overview:**

This conference will bring together stakeholders from the electric-drive industry [including, hydrogen fuel cell and plug-in battery electric vehicle (EV) sector representatives] to discuss funding; policy; and challenges and solutions of large scale infrastructure deployment and electric drive vehicle adoption. Conference presentations will review the current electric drive industry in Hawaii and discuss challenges and solutions to larger scale infrastructure development and vehicle deployment. Experts will provide critical information and case studies to help better align Hawaii with the wider electric drive industry and its anticipated development. The conference will also be used to gather feedback to support the development of a revised transportation plan under the Hawaii Clean Energy Initiative, which aims to achieve deep reductions in petroleum use in the State of Hawaii.

**Background:**

In 2014 the Hawaii State Energy Office has convened a planning process or "charrette" analysis to provide the underlying assessments, analysis, and recommendations for an updated Hawaii Clean Energy Initiative transportation plan to significantly reduce the consumption of petroleum products in Hawaii's transportation sector. The primary purpose of the Hydrogen Fuel Cell and Battery Electric Vehicle Stakeholder Charrette is to support the analysis with regards to the feasibility of implementing electric-drive infrastructure for several usages across the State of Hawaii that may also support grid balancing, and energy assurance objectives. Hydrogen fuel cell and plug-in battery EVs are complementary technologies and both are important strategies that will contribute towards the reduction of petroleum in ground transportation. The charrette will further explore the degree to which hydrogen fuel cell and plug-in battery EVs can contribute to reductions in petroleum-based fuels in the transportation sector. Moving forward with these advanced transportation technologies will greatly contribute to meeting this level of reductions.

**Conference Structure:**

The stakeholder conference is supported by the Department of Business, Economic Development & Tourism. Dr. Alan Lloyd, President Emeritus of The International Council on Clean Transportation (ICCT) will serve as lead facilitator.

January 13-14, 2015

International Trade Resource Conference Center
Hawaii Foreign Trade Zone #9 at Pier 2

**Hydrogen Fuel Cell and Battery Electric Vehicle Stakeholder Charrette**
Expanding Hawaii's Clean Transportation Solutions

**Day 1 – January 13, 2015**

**8:30 a.m.** **Registration**

**9:00 a.m.** **Welcome, Introductions, Conference Background, Objectives, and Desired Outcomes**

*Mark Glick, Energy Administrator, Hawaii State Energy Office*

**9:30 a.m.** **Context for Focus on Electric Drive within Hawaii Clean Energy Initiative**

*Dr. Alan Lloyd, President Emeritus, International Council on Clean Transportation (ICCT)*
*Joshua Miller, Researcher, ICCT*

**10:00 a.m.** **Current Status and Near Term Activities for Plug-in EVs in Hawaii**

*Moderator: Jeff Mikulina, Executive Director, Blue Planet Foundation*

*Marc Deutsch, EV Business Development Manager, Nissan North America*
*Carlos Perez, Manager of Customer Solutions, Hawaiian Electric Companies;*
*Dexter Turner, President/CEO OpConnect*
*Michael Chang, Chief Innovations Architect & Technology Director, Hawaii Energy*

**11:30 a.m.** **Lunch: Hosted by Blue Planet Foundation**

**1:00 p.m.** **Current Status and Near Term Activities for Hydrogen Vehicles in Hawaii**

*Moderator: Brigadier General (ret) Stan Osserman, Executive Director, Hawaii Center for Advanced Transportation Technologies (HCATT)*

*Dr. Richard Rocheleau, Director, Hawaii Natural Energy Institute (HNEI)*
*Paul Ponthieux, Chief Technology Officer, Blue Planet Research*
*Alex Keros, Manager, Advanced Vehicle and Infrastructure Policy, General Motors*
*Thorton Toma, Senior Vice President, Servco Hawaii*

**2:30 p.m.** **Current and Proposed Legislation for Promotion of Electric Drive Vehicles**

*Senator Mike Gabbard, Chair of the Committee on Energy and Environment (Oahu)*
*Representative Mark Nakashima, Member of Transportation Committee (Hawaii)*

**3:00 p.m.** **Day 1 Summary/ Day 2 Overview**

*Dr. Alan Lloyd, President Emeritus, ICCT*

**4:00 p.m.** **Networking Reception hosted by**

**Hydrogen Fuel Cell and Battery Electric Vehicle Stakeholder Charrette**
Expanding Hawaii's Clean Transportation Solutions

**Day 2 – January 14, 2015**

**9:00 a.m.** **Welcome Remarks and Presentations from Invited Contributors Outside Hawaii**

*Moderator: Dr. Alan Lloyd, President Emeritus, ICCT*

*Robert Rose, Executive Director, Fuel Cells 2000/Breakthrough Technologies Institute*
*Jaimie Levin, Director of West Coast, Center for Transportation and The Environment*
*Pete Devlin, Fuel Cell Technologies Program, U.S. Dept. of Energy*
*Eileen Wenger Tutt, Executive Director, California Electric Transportation Coalition*
*Tyson Eckerle, Zero Emissions Vehicle Infrastructure Project Manager, California Governor's Office of Business and Economic Development*
*Abas Goodarzi, President, U.S. Hybrid*

**10:30 a.m.** **Break**

**10:45 a.m.** **Panel Discussion from Invited Contributors Outside Hawaii**

*Moderators: Dr. Alan Lloyd, President Emeritus, ICCT*
*Ken Kelly, National Renewable Energy Laboratory*

**12:30 p.m.** **Lunch: Hosted by Blue Planet Foundation**

**1:30 p.m.** The afternoon session will be split into two tracks before reconvening as a whole group. Moderators will be asked to discuss and identify policy, economic development opportunities, budget needs and recommendations, conflict areas and synergies with hydrogen and plug-in EVs, and suggestions/solutions to fueling infrastructure and vehicle deployment.

**Breakout Session 1: Hydrogen**
*Moderator: Mitch Ewan, Hydrogen Systems Program Manager, HNEI*

*The primary purpose of this breakout session is to discuss the feasibility of implementing hydrogen infrastructure across the State of Hawaii. This session will explore specific goals for vehicle and infrastructure deployment including:*

- *Status of hydrogen in Hawaii*
- *Fueling needs and installation timeframe*
- *Shortfalls and remedies: Role of Government, OEMs*
- *Hydrogen/electricity suppliers*
- *Energy security and assurance*
- *Economic development opportunities*

**Breakout Session 2: Plug-in EVs**
*Moderator: Greg Gaug, Senior Associate, Ulupono Inititive*

*The primary purpose of this breakout session is to discuss innovative and implementable programs and technologies that can help to address barriers to mass EV adoption and charging infrastructure installation in Hawaii. This session will "talk story" with leading EV companies and local stakeholders who are paving the way for clean transportation options in Hawaii.*

- *FreeWire*
- *PlugShare*
- *Volta*
- *EV Structure*
- *General Motors*

**3:30 p.m.** **Break**

**3:45 p.m.** **Breakout Session Report**

**5:00 p.m.** **Conclude Meeting**

# DISCLAIMER

**The views and opinions expressed in the Hydrogen Fuel Cell and Battery Electric Vehicle Stakeholder Charrette presentations are that of specific presenters, and may not necessarily represent the position of the Hawaii Strategic Development Corporation or Hawaii State Energy Office.**

# Context for Focus on Electric Drive Within Hawaii Clean Air Initiative (HCEI)

# Introductory Comments

*Alan C. Lloyd, President Emeritus, ICCT*

*Joshua D. Miller, Researcher, ICCT*

**January 13, 2015**

**Honolulu, HI**

icct

THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

# HCEI transportation industry analysis

- Hawaii State Energy Office contract with the ICCT
  - Analysis, recommendations, and stakeholder engagement
  - Support development of a revised clean transportation plan
  - Progress to date following the HCEI Roadmap 2011 Edition
  - Assess what can realistically be achieved by 2030
- "Transportation Charrette": Stakeholder consultations between November 2014 and June 2015
- New set of transportation options, goals and timeline
- Reduce use of petroleum-based fuels in aviation, ground and marine transportation

# Project timeline for transportation industry analysis

| Action | Nov-14 | Dec-14 | Jan-15 | Feb-15 | Mar-15 | Apr-15 | May-15 | Jun-15 |
|---|---|---|---|---|---|---|---|---|
| Workshop on analysis of HCEI 2011, fuels and TDM | | | | | | | | |
| Workshop on electric drive vehicles and fuels | | | | | | | | |
| Web-meetings on vehicle efficiency, aviation and marine tactics | | | | | | | | |
| Narrow down strategies and tactics | | | | | | | | |
| Qualitative and quantitative evaluation of tactics | | | | | | | | |
| Assess complementarity with existing Hawaii policies, plans and budgets | | | | | | | | |
| Second Transportation Sector Workshop – seek working agreement on plan and implementation steps | | | | | | | | |
| Final report | | | | | | | | |

# Comparison of 2015/2020 goals with 2013 status

| Strategy with 2010 baseline | 2015 target | 2020 target | 2013/2014 Actual |
|---|---|---|---|
| Reduce vehicle miles traveled (VMT) | 2% VMT reduction | 4% VMT reduction | 19% increase in VMT |
| Incorporate renewable fuels into transportation sector | E10 and biodiesel consumption at 2010 level | | 52 million gallons |
| Improve standard vehicle efficiency of fleet | 25 mpg cars<br>18 mpg LT | 30 mpg cars<br>22 mpg LT | 25 mpg for cars & LT combined |
| Accelerate the deployment of EVs and related infrastructure | 4K EV sales (10K on road) | 10K EV sales (40K on road) | 1K EV sales (3K on road) |
| **On-road fuel use of 496 MGY in 2010** | – | – | 525 MGY in 2013 (6% increase) |

# Strategies under consideration

1. Vehicle-miles traveled
2. Alternative fuels
3. Vehicle efficiency
4. **Electric-drive vehicles**
5. Marine
6. Aviation

# ICCT research on electric-drive vehicles 2013-2014

| Publication | Summary |
|---|---|
| Evaluation of state-level U.S. electric vehicle incentives (Jin, Searle, & Lutsey, 2014) | Introduces a novel methodology to monetize the benefit to consumers of electric vehicle incentives provided by U.S. states, and finds that more battery-electric vehicles are sold in states offering a greater total package of incentives. |
| Driving electrification: A global comparison of fiscal policy for electric vehicles (Mock & Yang, 2014) | Details differences in the fiscal policies used to support electric vehicle sales across eleven major auto markets. Tax exemptions and subsidies are playing a key role in spurring electric vehicle markets, but in widely divergent ways. |
| Analyzing the Transition to Electric Drive in California (Greene, Park, & Liu, 2013)* | Reports results of an exercise in modeling the transition to electric drive vehicles, including measuring the costs and benefits, quantifying the transition barriers and network external benefits, and estimating the effects of public policies on the transition process. |
| Zero-emission trucks: An overview of the state-of-the-art (Den Boer, Aarnink, Kleiner, & Pagenkopf, 2013)* | Battery-electric and fuel-cell trucks could be feasible in Europe within little more than a decade. Turning that possibility into reality is crucial to meeting long-term climate goals in the transport sector. |
| Electric vehicle grid integration in the U.S., Europe, and China (M.J. Bradley & Associates, 2013)* | Examines key drivers of EV adoption, with an emphasis on vehicle-charging scenarios and infrastructure and an eye toward identifying options that can maximize benefits from greater EV use to both consumers and the grid. |



*Sponsored by the International Council on Clean Transportation

# ICCT research on electric-drive vehicles 2011-2012

| Publication | Summary |
|---|---|
| Vehicle electrification policy study: Task 1 — Technology status (Shulock, Pike, Lloyd, & Rose, 2011) | Part 1 of a five-part policy study, summarizing the current status of vehicle and infrastructure technologies. |
| Vehicle electrification policy study: Task 2 — Metrics (Shulock, Pike, Lloyd, & Rose, 2011) | Part 2 of a five-part policy study, summarizing the current status of vehicle and infrastructure technologies. |
| Vehicle electrification policy study: Task 4 — Complementary policies (Shulock, Pike, Lloyd, & Rose, 2011) | Part 4 of a five-part policy study, summarizing the current status of vehicle and infrastructure technologies. |
| Calculating electric drive vehicle GHG emissions (Pike, 2012) | Proposes methods for determining EV efficiency, energy supply GHG intensity, and other factors that provide a basis for calculating upstream emissions. |

# Background to Meeting

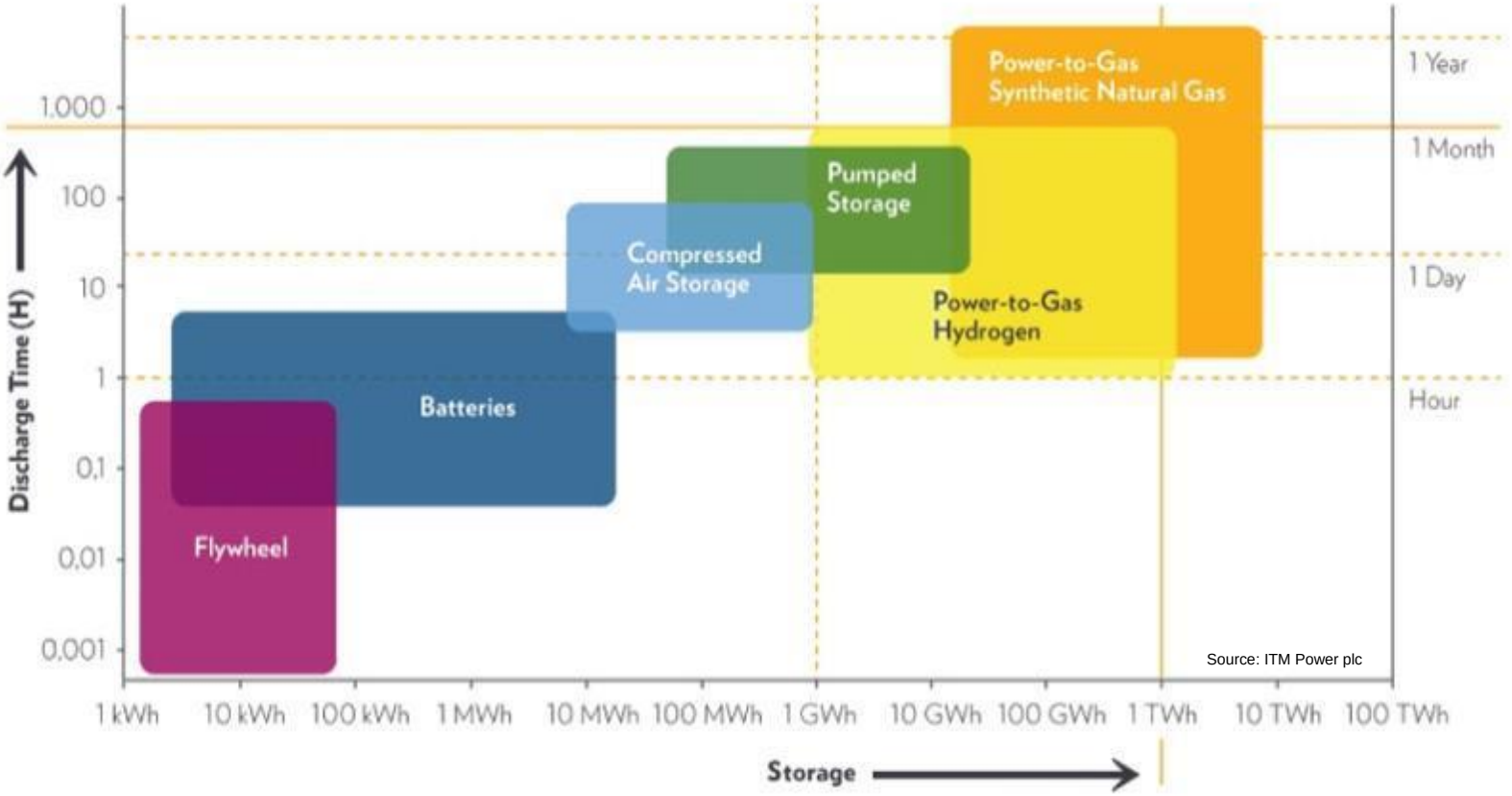
- Josh described context of E-drive within HCEI
- E-drive offers potential for completely renewable system – Both GHG and criteria pollutants
- Hawaii has an abundance of renewable energy and limited geographic area – Ideal for EVs.
- This charrette is part of study to move beyond optimistic projections to deployment of HCEI updated numbers shown above – appear to be overly optimistic

# Why Timing is Good for this Hawaii Initiative

- Major changes in the last 5+ years
  - Car manufacturers are selling BEVs in significant numbers
  - Toyota and Hyundai offering FCEVs, and can buy Toyota Mirai will be offered for sale in 2015
  - Increasing targets for renewable energy
  - Renewables need storage to address their intermittent nature – Both batteries and fuel cells are key technologies, as described below

# ENERGY STORAGE TECHNOLOGIES!

**Power-to-gas is efficient | long term | low energy cost**

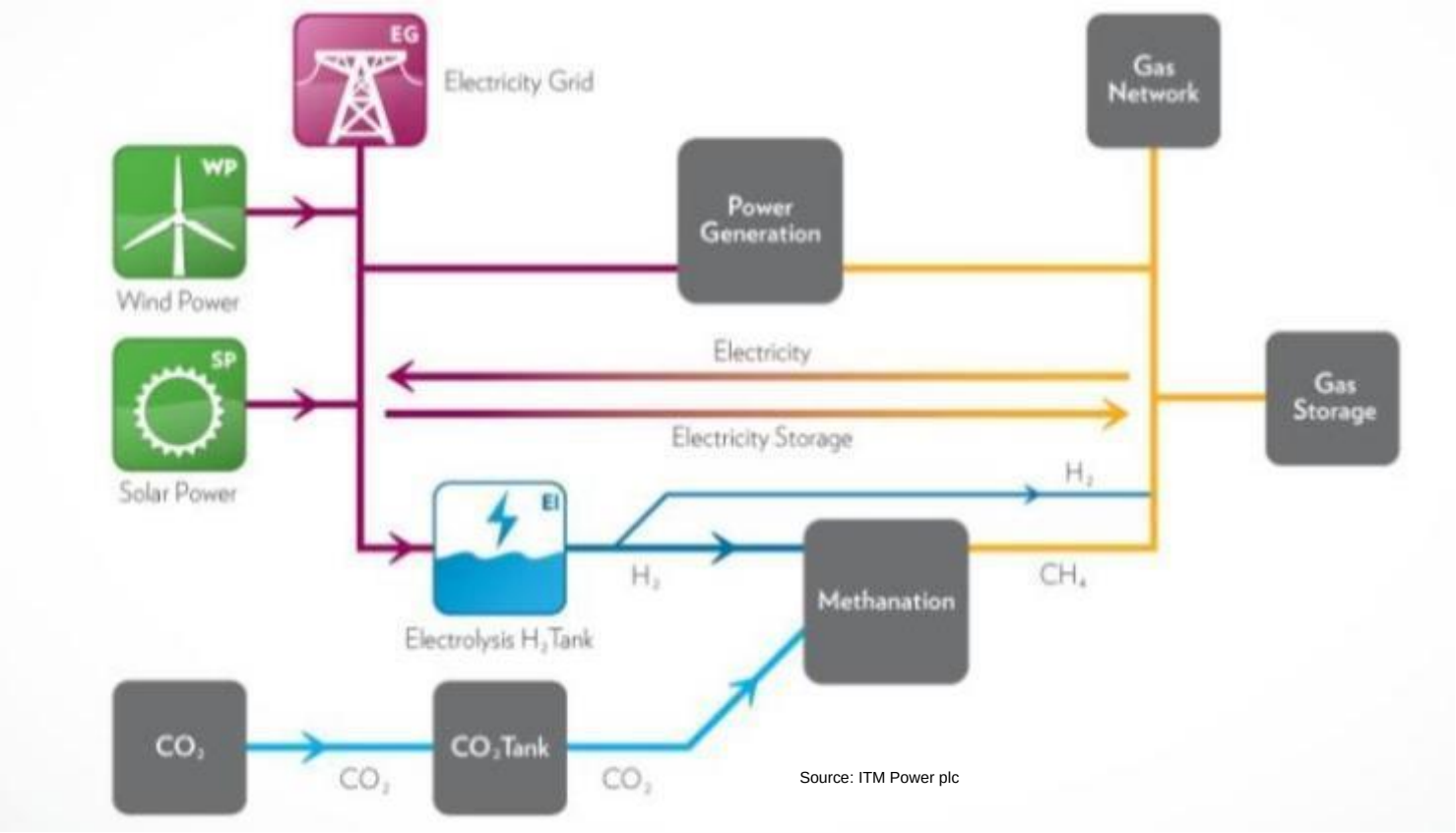


# Diversity of Application

- Hydrogen is produced by rapid response electrolyzer using renewable energy from wind or solar
- Oxygen is a co-product that has commercial value
- Hydrogen can be used in several ways:
  - Injected into natural gas grid
  - Reacted with external source of CO2 to produce renewable methane, which can be injected into NG pipeline
  - Utilized in fuel cell vehicles in transportation sector

# WHY POWER-TO-GAS?!

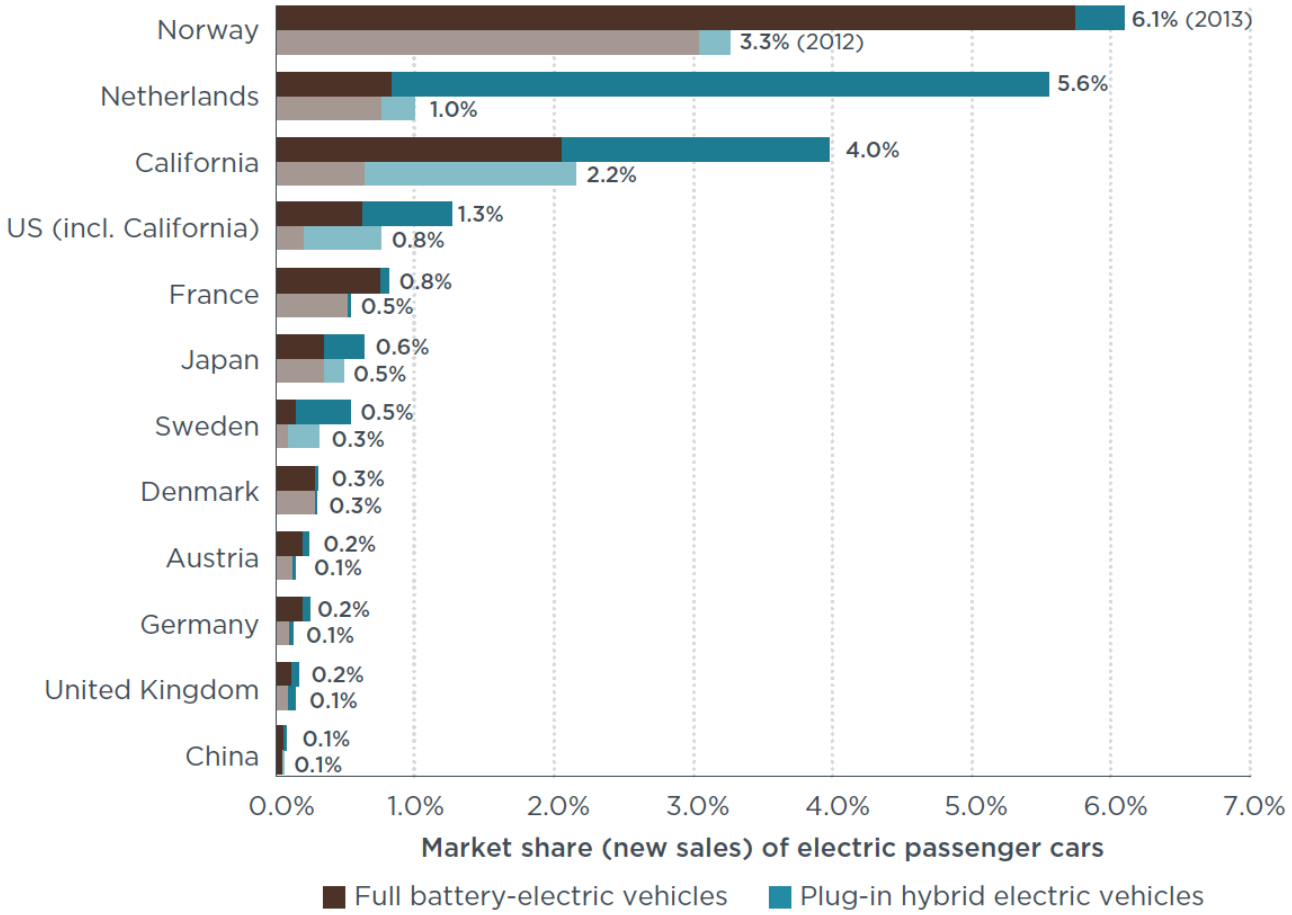
**Electricity cannot be stored easily | Hydrogen can be stored easily in the gas grid**




Source: ITM Power plc

# Some countries are quickly transitioning to low-carbon vehicles…

**Market share of electric cars in comparison to total sales in 2012/13**

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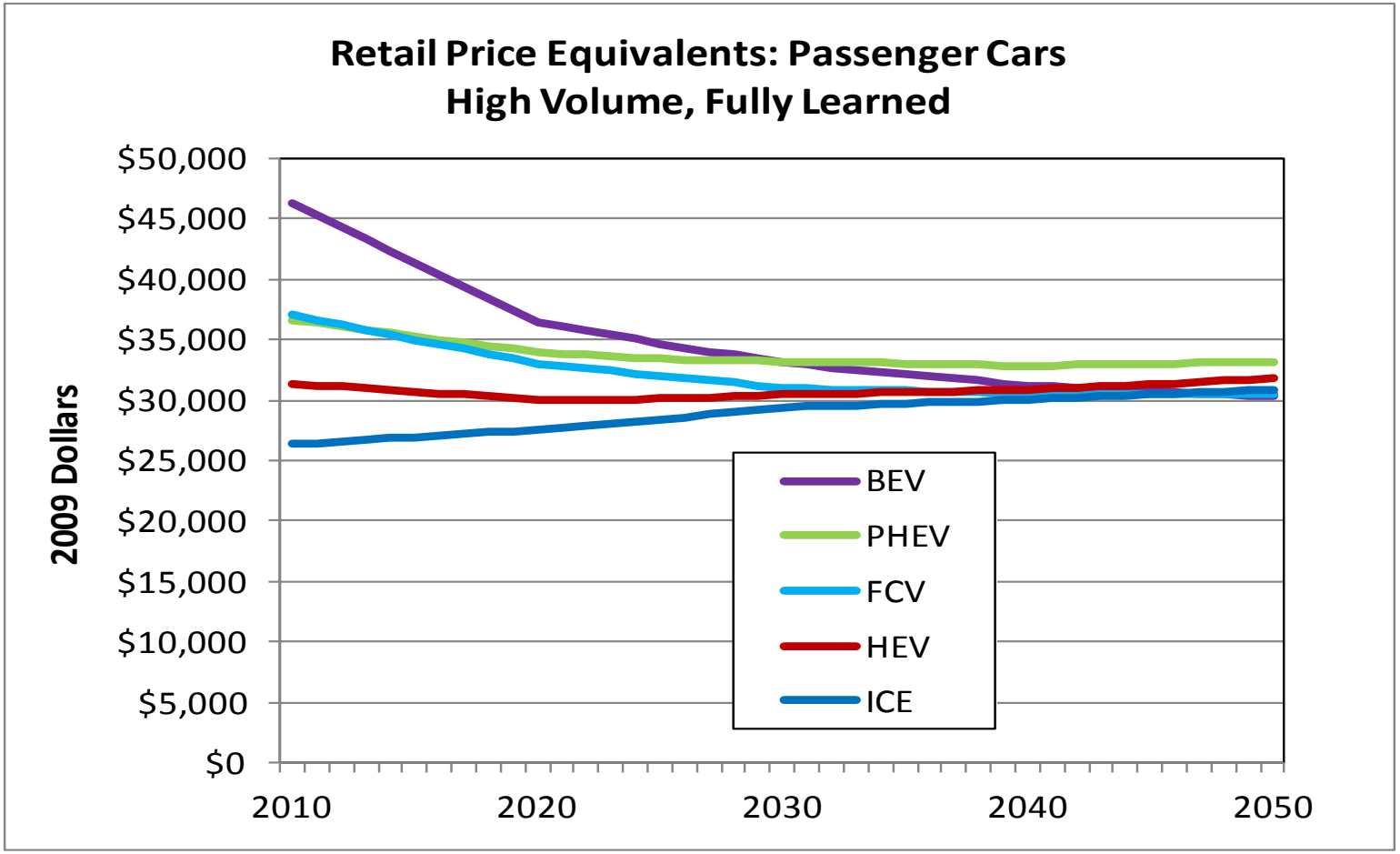
# Key Studies on Transition Time and Costs to E-Drive

- National Academy of Sciences Study: “Transitions to Alternative Vehicles and Fuels” March 2013
- Included new cost curves for existing and new drive trains prepared by John German (ICCT)
- Same model used by David Green for NAS and ICCT studies

# Fully Learned, High-volume Costs for BEVs and FCVs Become Lower than PHEVs, HEVs And ICEs



# Sustained Investment is Justified

- Given expected technology progress and strong public policies, benefits of transition to electric drive appear to be about 10X greater than costs
- Additional investment is justified based on large benefits of achieving the transition
  - NPV of $190-290B for CA and Section 177 states

# Hydrogen no longer the fuel of the future

"According to energy-industry wags, there are several candidates for the accolade of 'fuel of the future...and always will be.' But whereas advanced biofuels and nuclear fission can still make a fair claim to the title, hydrogen fuel cells will become a fuel of the present in 2015."

Source: Wright, S. (2014). "Foot on the gas." *The Economist*.

# Our Goal for Next 2 Days

- Presentation of ongoing and future work in Hawaii
- Comments and suggestions from mainland experts
- Consensus building for realistic numbers of EVs in 5 year increments to 2030 will be used in ICCT modeling
- Develop action items from the meeting, including infrastructure, financial, administrative and legislative requirements

# Thank You!

# blue planet FOUNDATION

# 451,533,116

gallons of gasoline in 2014

# $1,919,323,339.99

Hawaii's first car arrived in 1899.

It was Electric.

Prince Kuhio and his new car.

# Would You Ride On Horse Cars Were They Running Today?

Electricity holds as unquestioned a superiority in the matter of lighting as it does in the matter of transportation.

## Don't Be A "Horse Car Man"

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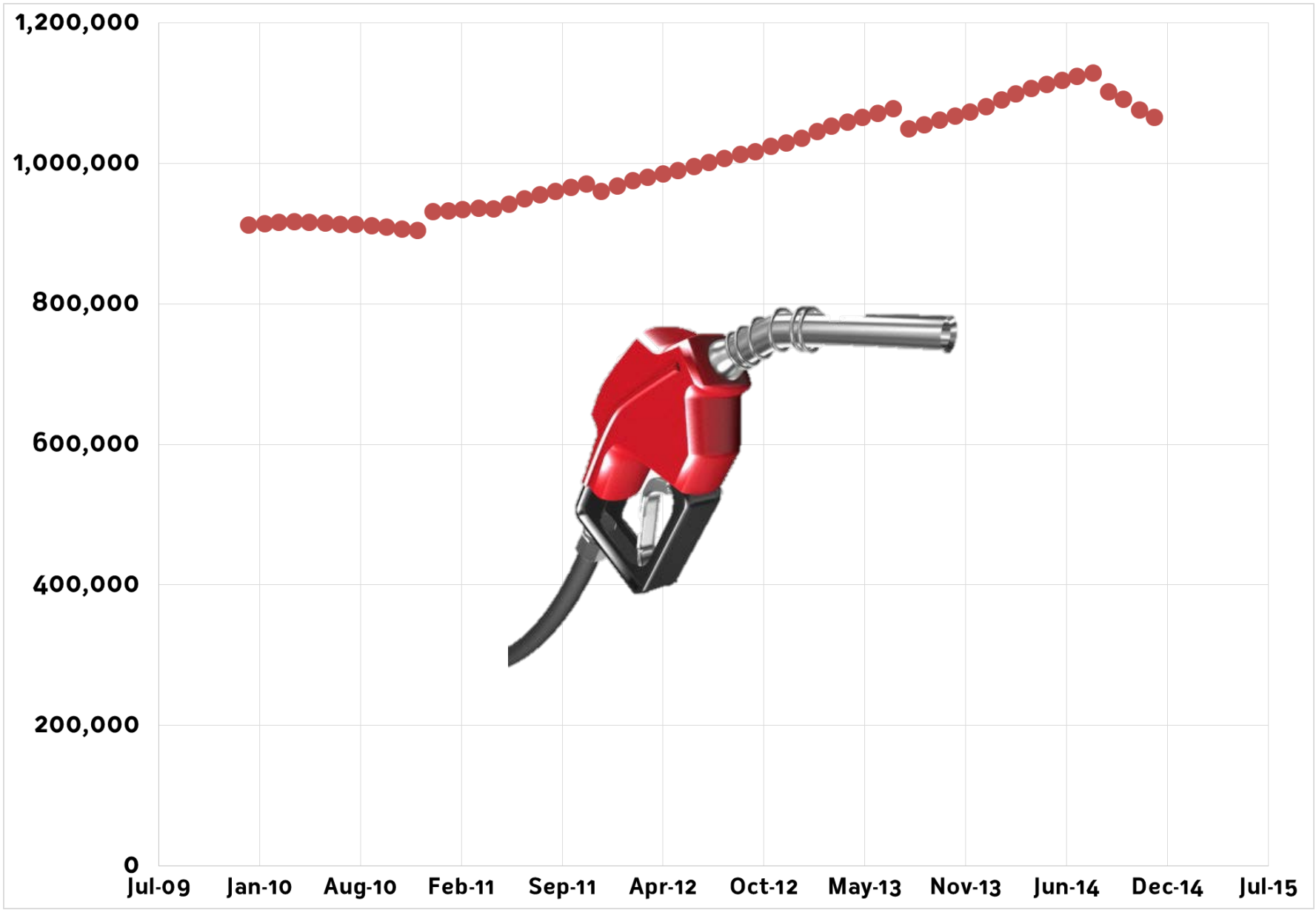
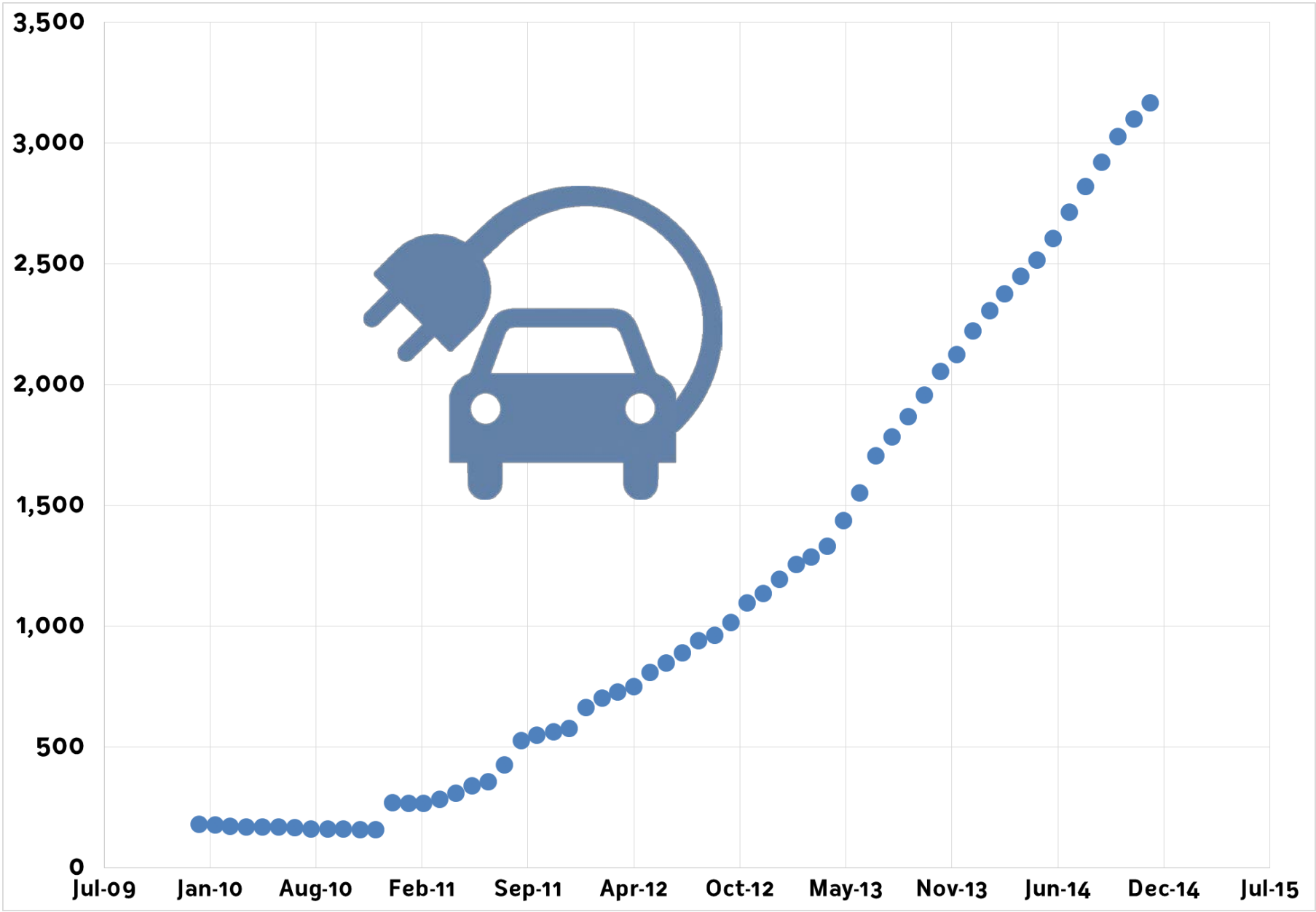
## Hawaiian Electric Co., Ltd.

KING ST. NR. ALAKEA. PHONE MAIN 390.

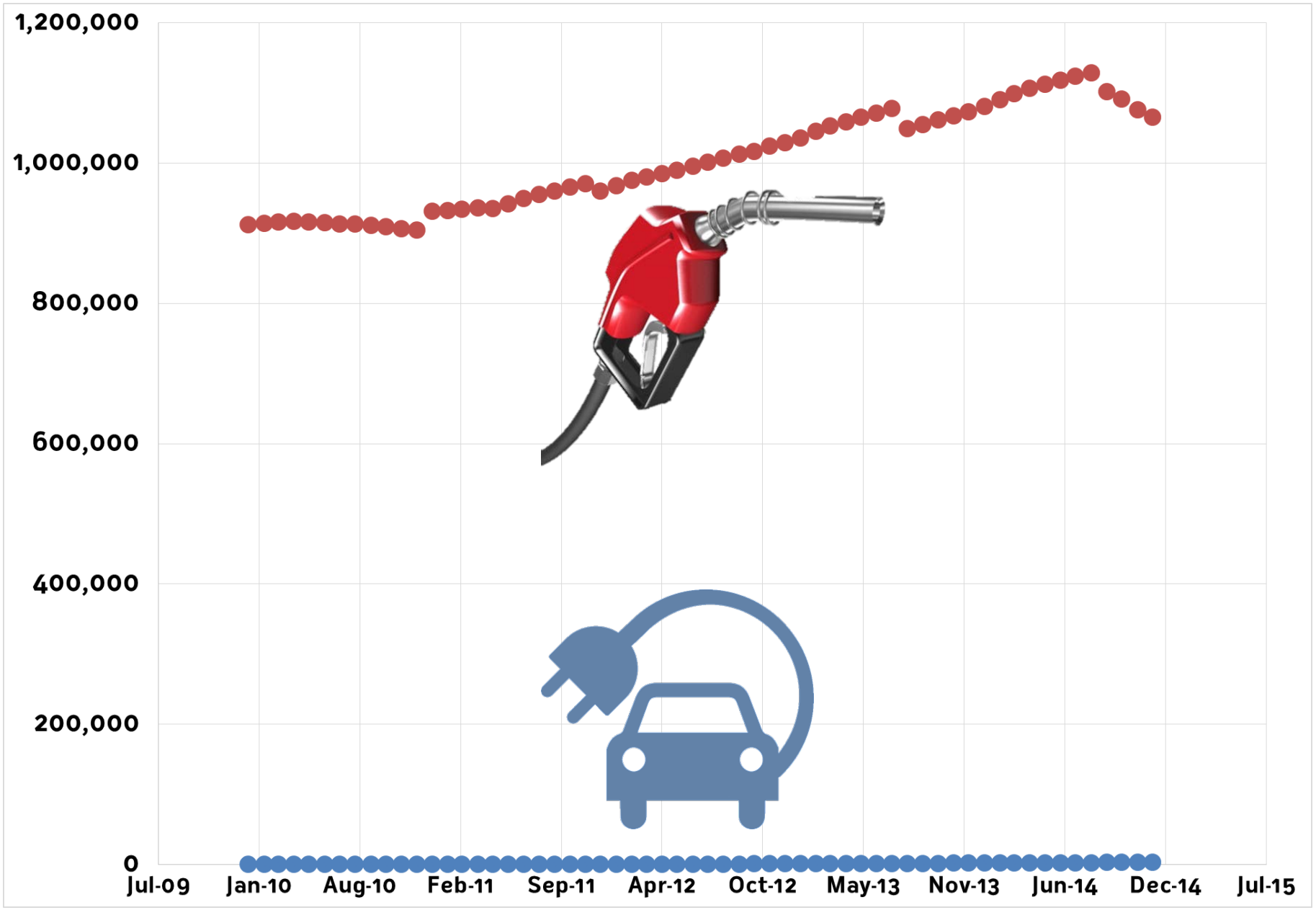
# Trend in Hawai‘i registered gasoline powered passenger vehicles



# Trend in Hawai‘i registered ELECTRIC passenger vehicles



# Trend in Hawai‘i passenger vehicle registrations

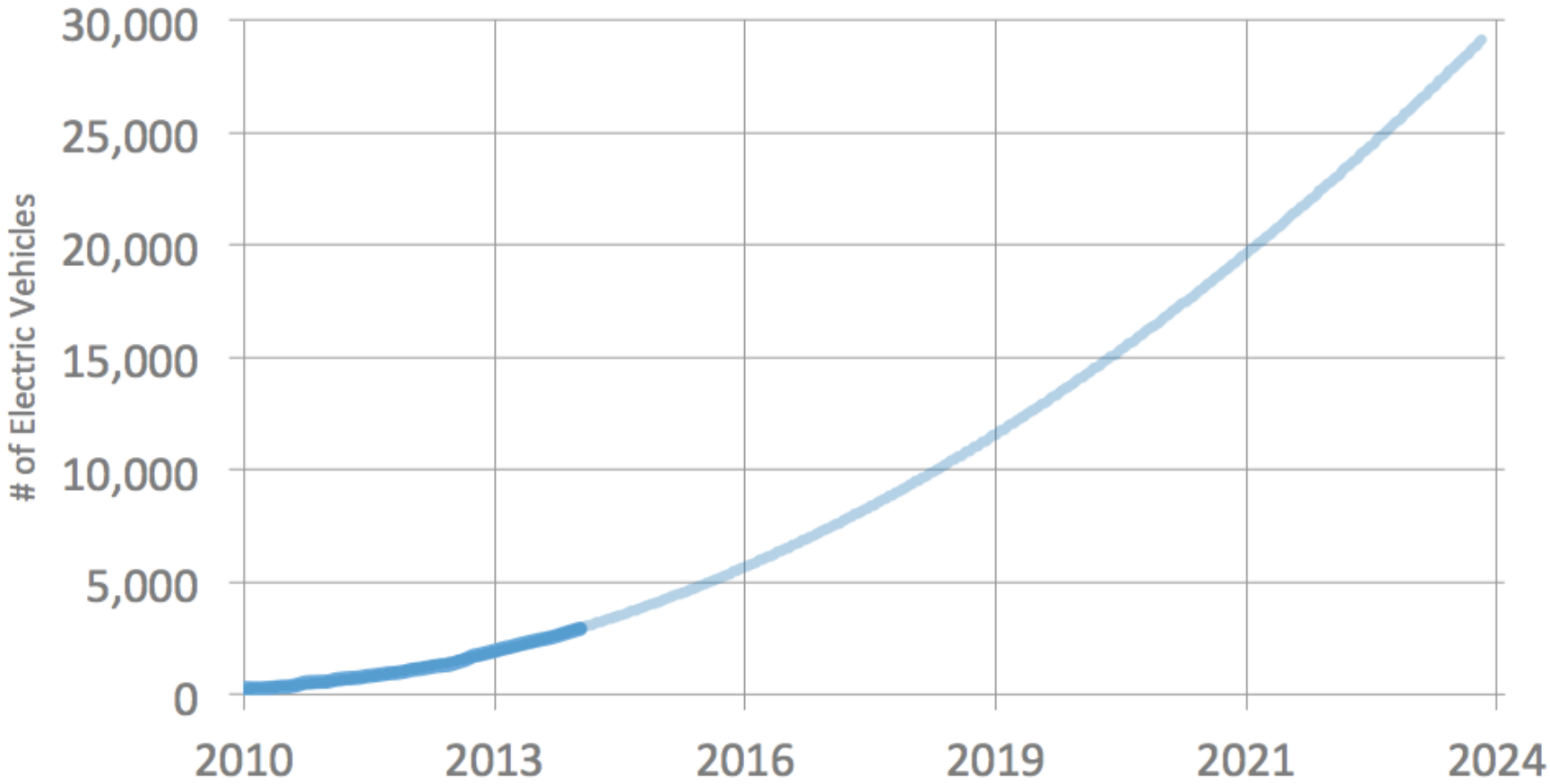


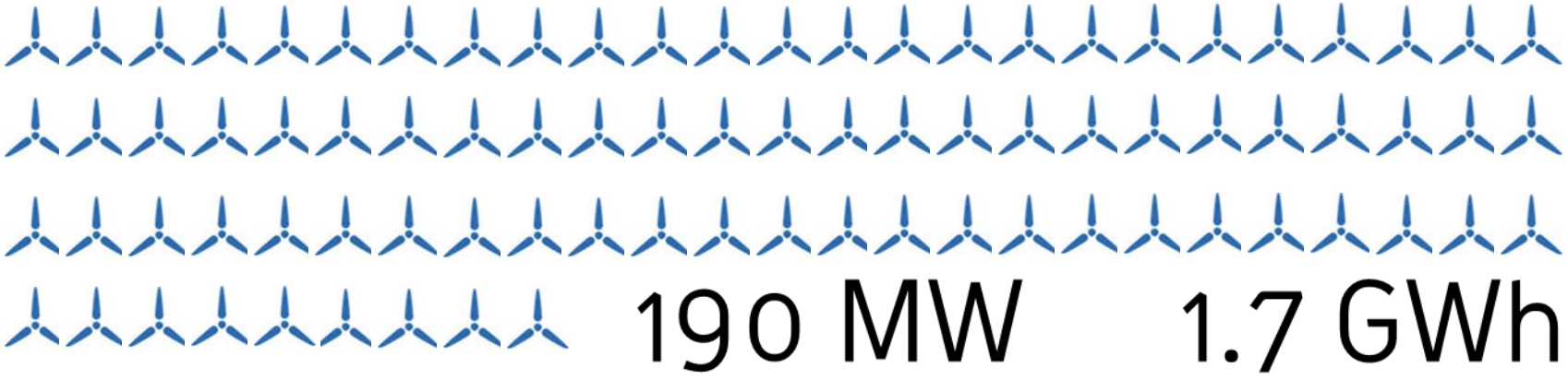

SOUL EV


M GI 3344


e-GOLF
e-Golf


LEAF


30,000
25,000
20,000
15,000
10,000
5,000
0
# of Electric Vehicles
2010
2013
2016
2019
2021
2024


190 MW
1.7 GWh

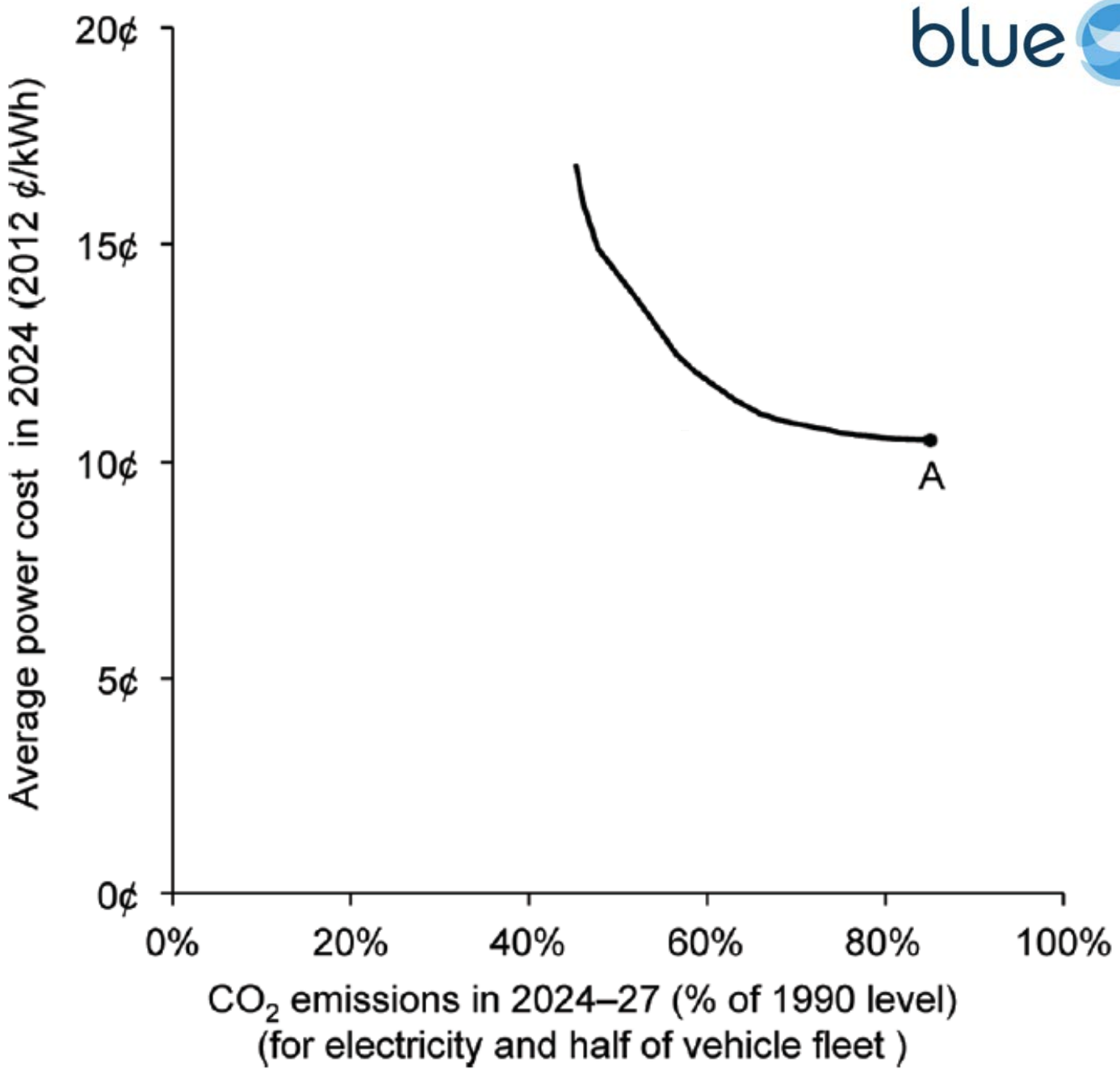
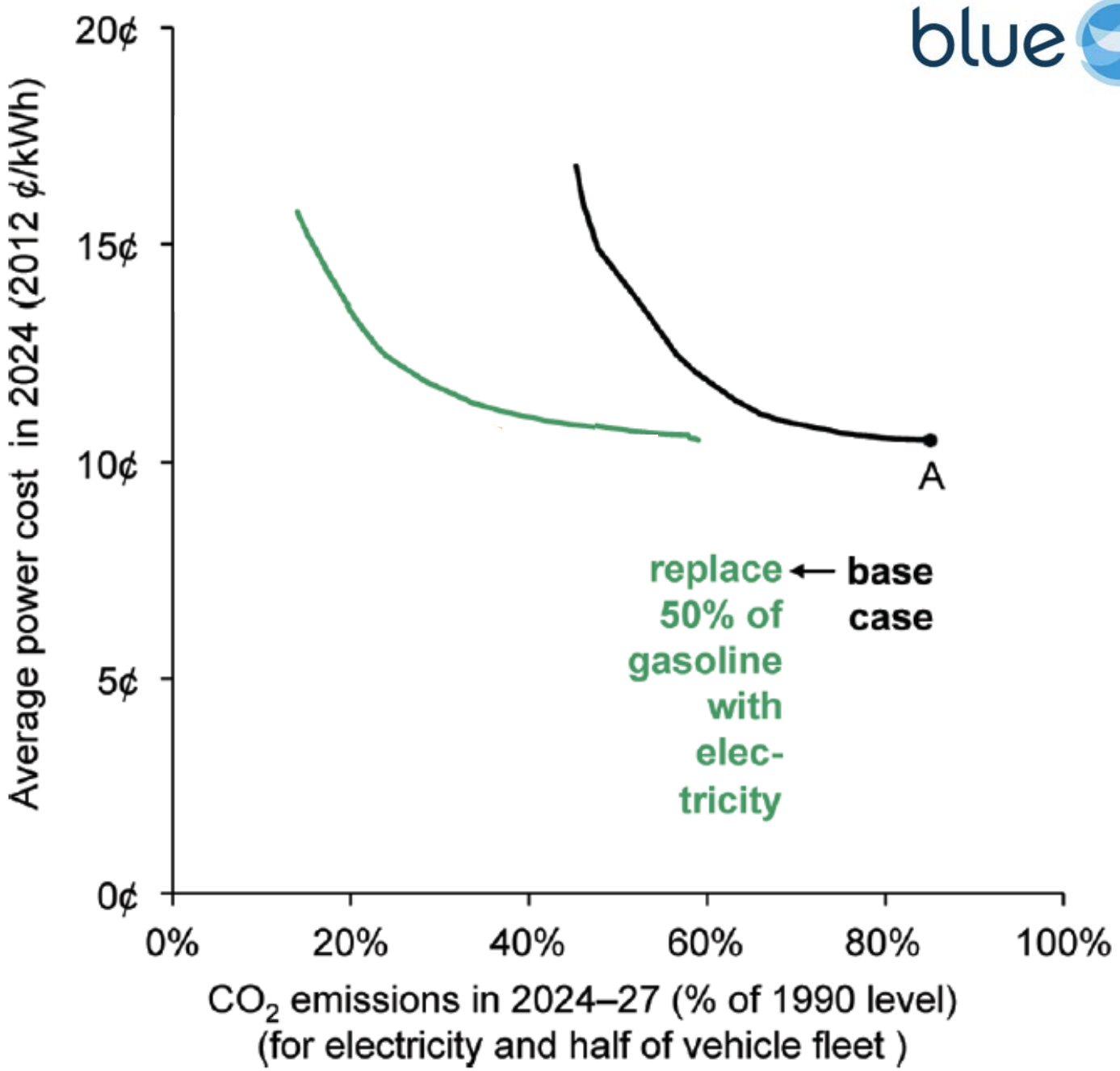



Fig. 5, M. Fripp, 46 ENVTL. SCI. & TECH. 6371 (2012).

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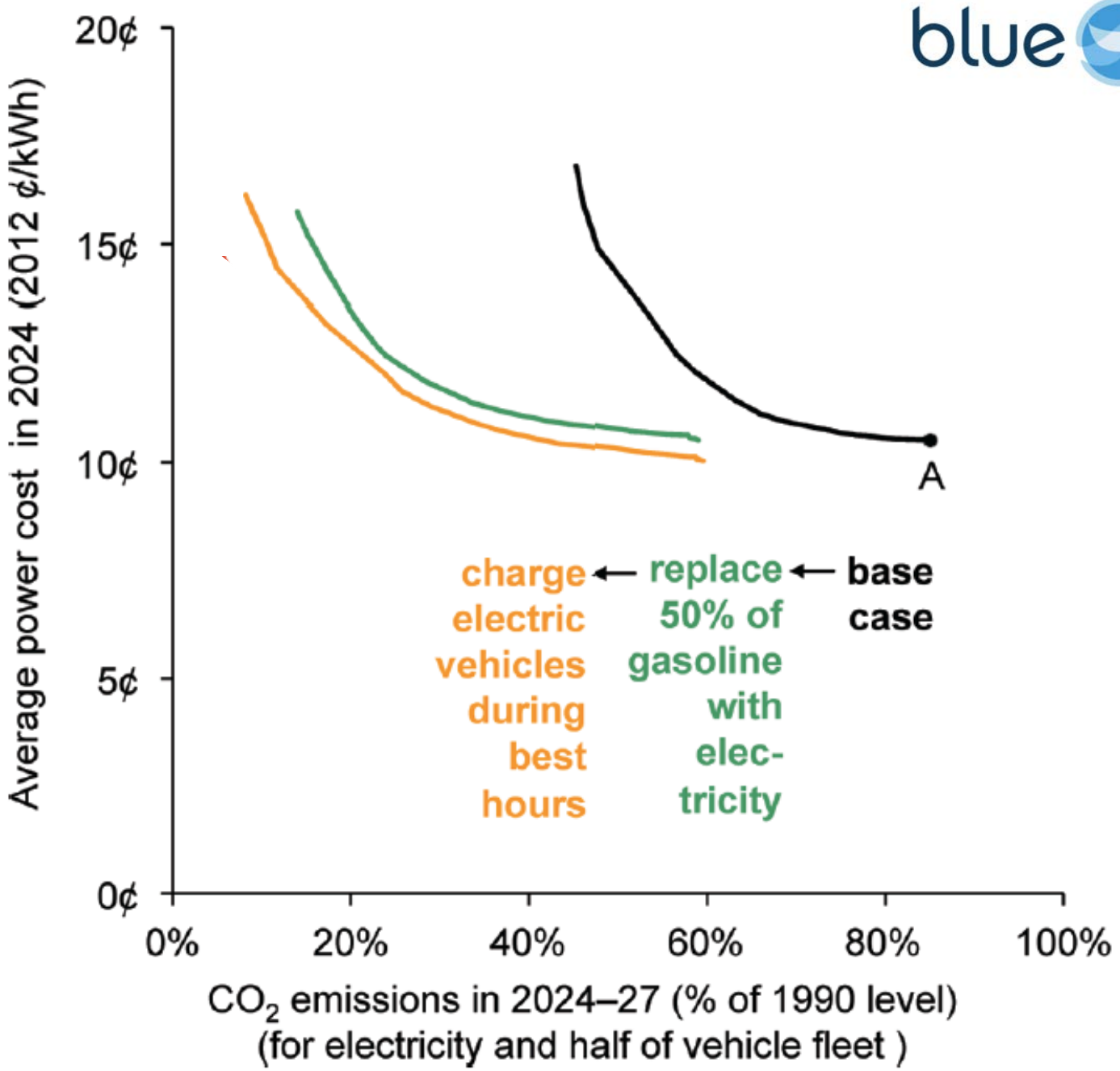


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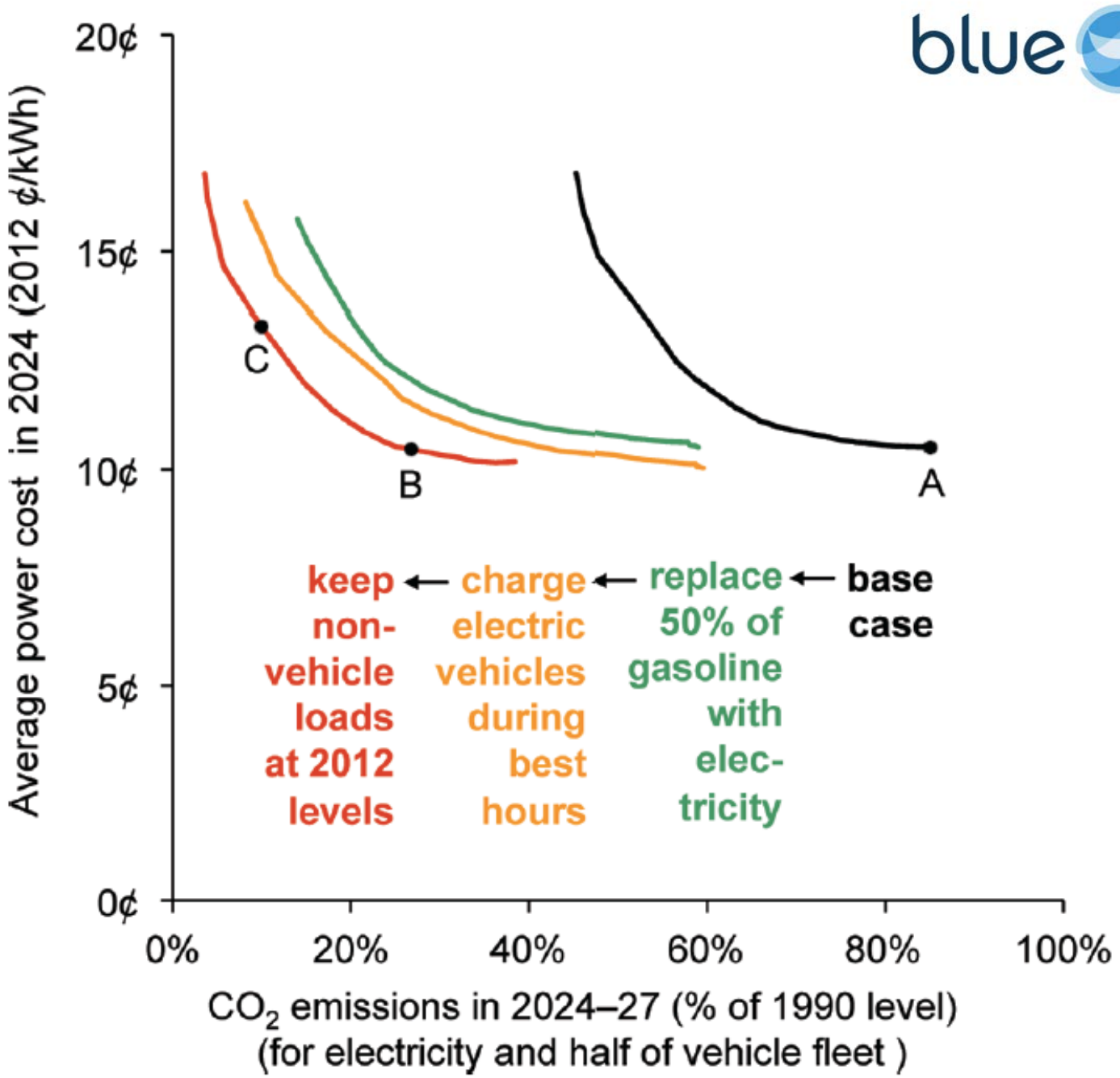



Fig. 5, M. Fripp, 46 ENVTL. SCI. & TECH. 6371 (2012).


AV


freeWire
Better EV Charging
MOBI

blue planet FOUNDATION

jeff@blueplanetfoundation.org
808-954-6142

**blueplanetfoundation.org**

**Blue Planet Foundation**

**BluePlanetFound**


# LEAF in Hawaii

## Over 30,000 LEAFs sold in 2014!

zero Emission

# Sales Performance

- 23 straight months of record US sales
- Best US December Ever:
- Best month for Hawaii in CY14: 100 units in August
- **Hawaii in NATIONAL TOP 5 for CY2014**

**Top Nissan model for Total Sales in:**

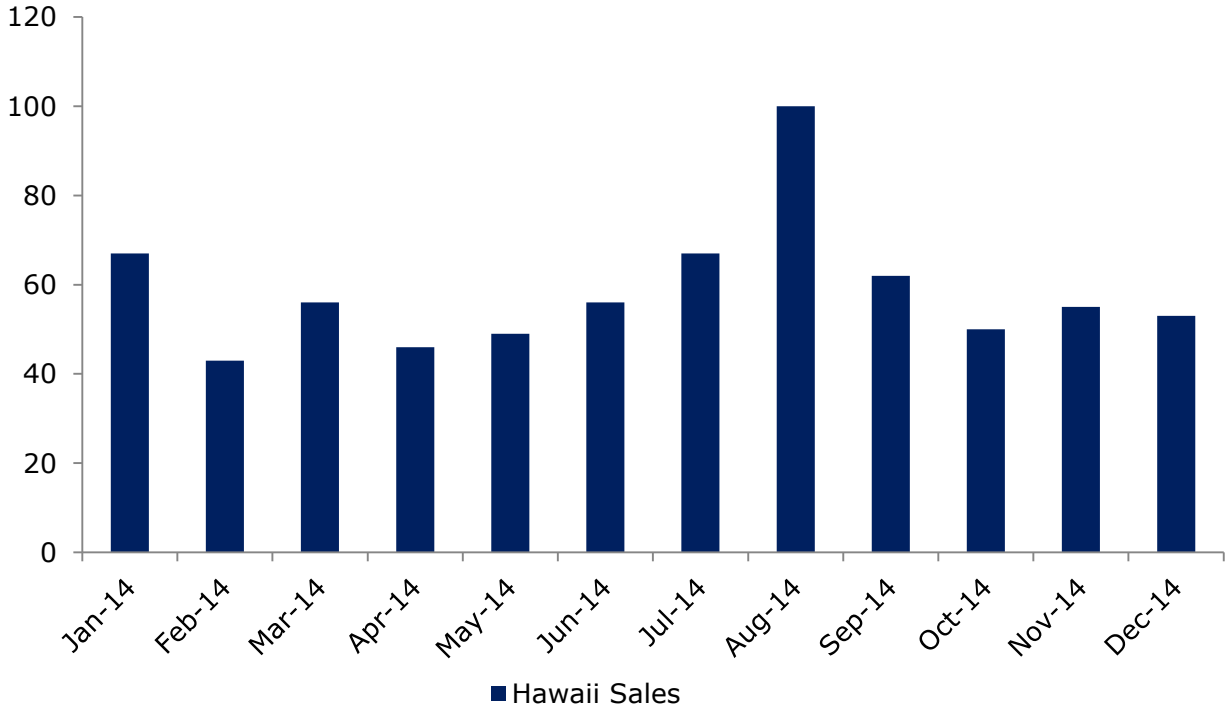
1st – Atlanta (by 796 units over Altima) and Seattle
2nd – San Francisco
4th – Honolulu & Portland, OR

**Top Nissan model for Retail Sales in:**

1st – Atlanta, San Francisco and Seattle
3rd – Portland, OR
4th – Honolulu
5th - Sacramento

| UIO | NTL | HI |
|---|---|---|
| Calendar YTD | 30,200 | 713 |
| Market Share | 25% | 55% |

# CY14: Strong Performance…




## CY14 Retail Sales

| National | Hawaii |
|---|---|
| 30,200 | 713 |

NISSAN

Innovation that excites

ZERO Emission

# Segment Opportunity

- **LEAF outsold Volt in 2014!**
- LEAF soon to beat Volt Launch-to-Date (if current trends continue)
- Key Differentiators:
  - Lower MSRP
  - Competitive LPP
  - DC Fast Charging
  - Workplace Charging
  - No Gas

**Increase Sales**

- Education
  - Through Ride and drives and more
- Infrastructure
  - Both Level2'sandDCQC
  - MUD's
- PV – EV connection
- State Rebate

# Dealers and DCQC

Innovation that excites

## LEAF Certified Dealers

- All Nissan dealers in Hawaii except for Kamaaina on the Big Island are LEAF Certified

## Special Programs

- VPP
- Workplace Charging
- Fleet

## Top Sales Person

- Kurt Speas
- Ranked #2 in the US
- 550+ sales

## Public Fast Chargers

- US: 810
- Oahu: 6 (HI: 15)

# Future of Nissan LEAF

NISSAN

Innovation that excites

- More Models
  - eNV200
- Range Increase
- V2G
- 2nd generation in 2017
- Autonomous Vehicle
- …

Zero Emission

# Questions

MARC DEUTSCH
EV Business Development Manager
Marc.Deutsch@NissanUSA.com
619,693.0544


Innovation that excites

Zero Emission

# Hawaiian Electric Companies


# Electric Vehicle Programs Update

Hawaiian Electric

# Hawaiian Electric Companies' EV Project Involvement

- Hawaii Renewable Energy Development Venture
- Hawaii EV Ready Program
- EPRI "Carport of the Future"
- EPRI Chevy Volt Demonstration Project
- DC Fast Charger with Buffer Battery
- Load curtailment (DR) on CHAdeMO DC fast charging

Hawaiian Electric

# Hawaiian Electric Companies' Plug-In Electric Fleet

- Hawaiian Electric
  - 16 BEV passenger vehicles, 16 PHEV passenger vehicles, and one converted Prius
  - 1 truck with plug-in electric aerial buckets
- Hawai'i Electric Light
  - 5 BEV passenger vehicles
  - 8 trucks with plug-in electric aerial buckets
- Maui Electric
  - 2 BEV passenger vehicles
  - 7 trucks with plug-in electric aerial buckets

Hawaiian Electric

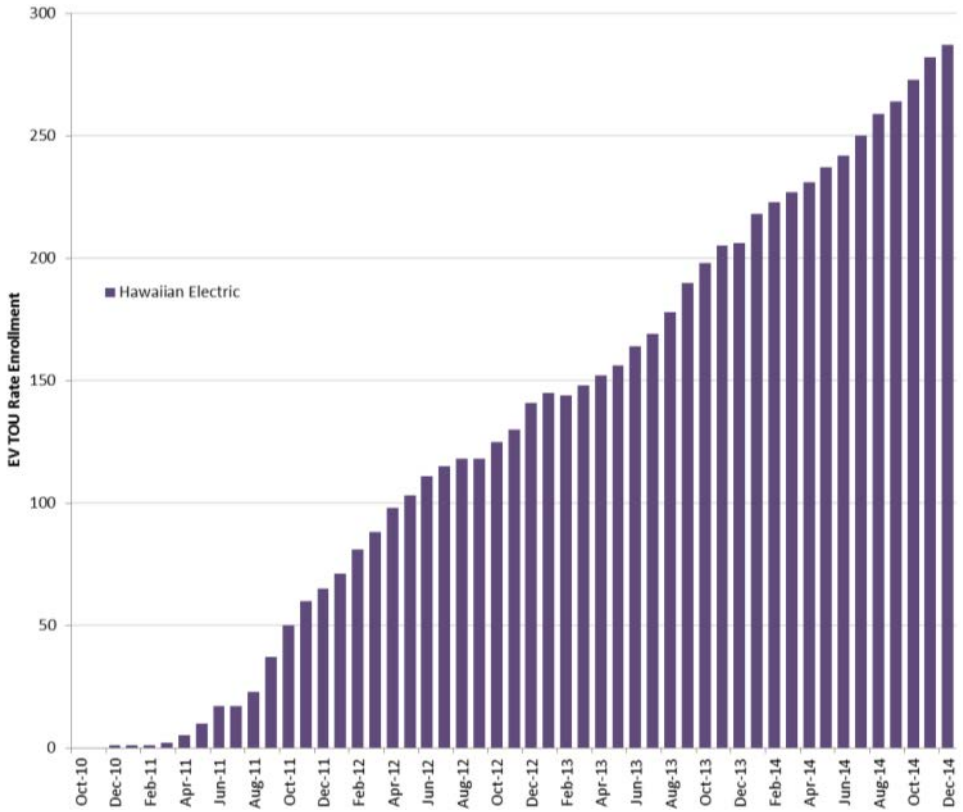
# EV Rates

## Time of Use Rates for EV Owners

- Pilot program (2010 – 2014)
  Continued through September 2015
- Three optional rates - all Time Of Use (TOU):
  - Residential
    - TOU EV
      Whole house meter, 3 rate periods
    - EV-R
      Separate meter for EVSE, 2 rate periods
  - Commercial
    - EV-C
      Separate meter for EVSE, 2 rate periods

# EV Rates
## Enrollment

- Hawaiian Electric
  - TOU EV 284
  - EV-R 6
- Hawai'i Electric Light
  - TOU EV 8
  - EV-R 0
- Maui Electric (Maui)
  - TOU EV 33
  - EV-R 1

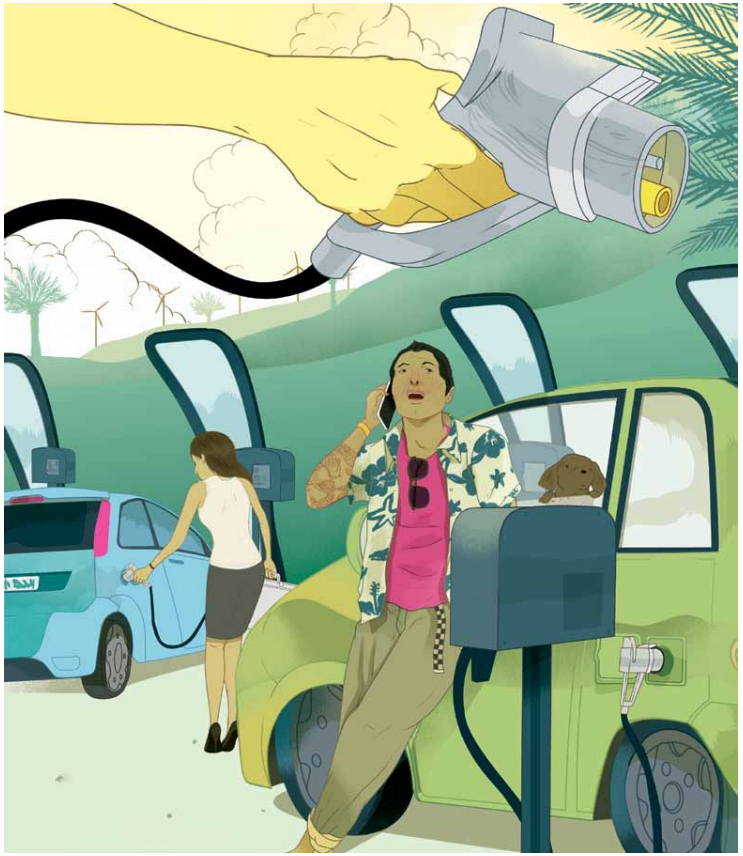



As of the end of 2014.

Hawaiian Electric

# EV Rates and Renewables

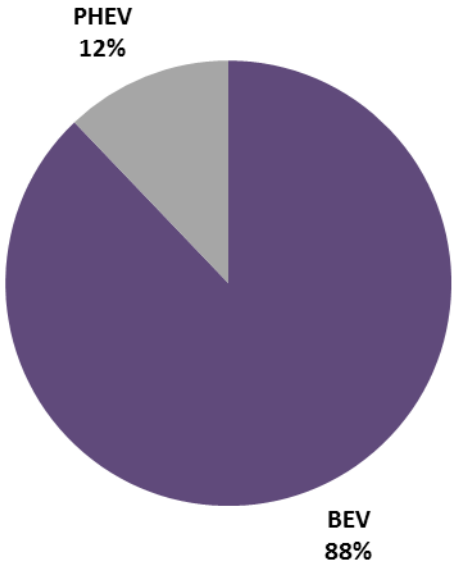
- Net Energy Metering participants
  - Hawaiian Electric 75%
  - Hawai'i Electric Light 80%
  - Maui Electric 57%



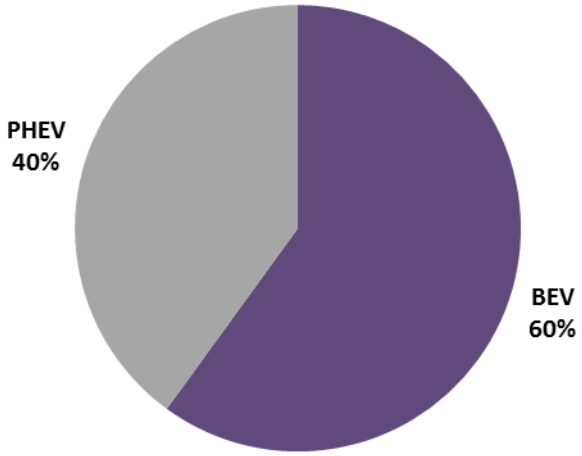
As of the end of 2013.

# EV Types on Rate

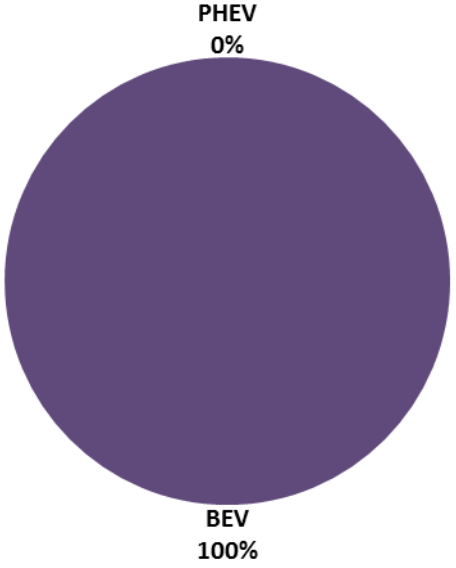
- Breakdown of PHEV and BEV rate participants by Company territory.




Hawaiian Electric




Hawai'i Electric Light

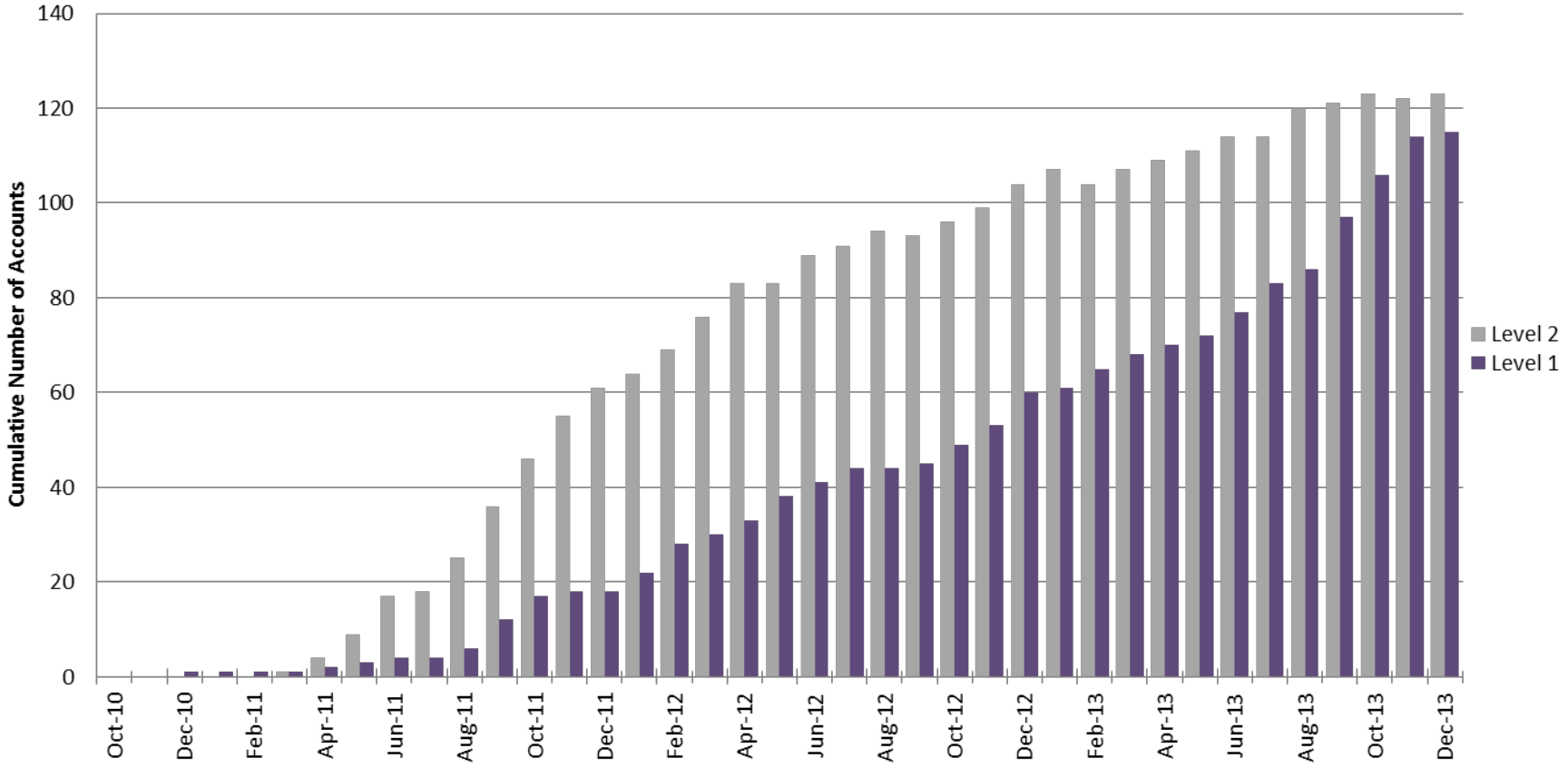



Maui Electric

As of the end of 2013.

# Pilot Residential Rate Charging

- Residential charging level indicated by participants at time of rate enrollment



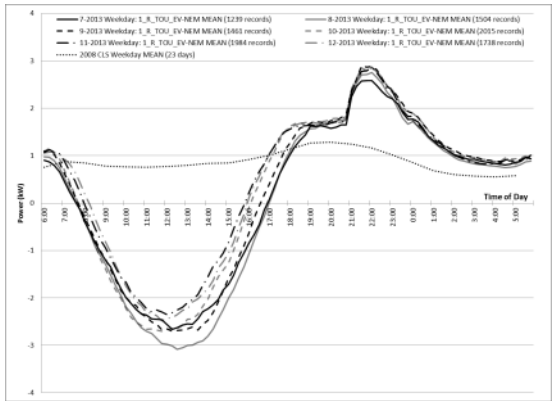

Hawaiian Electric as of the end of 2013.

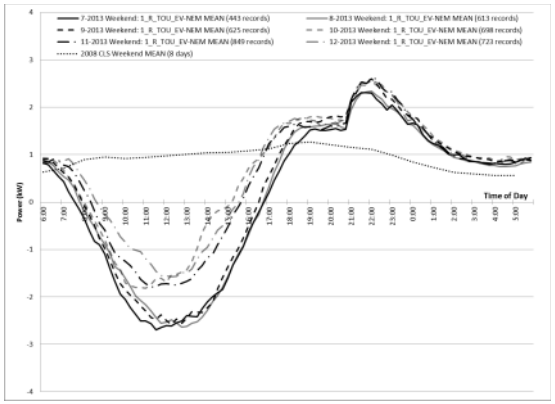
Hawaiian Electric

# EV Rates

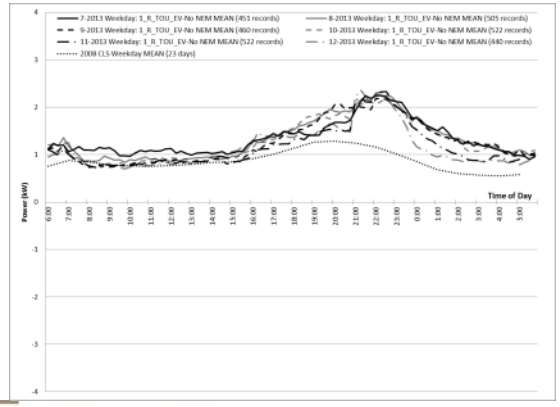
## Load Study - Rate Participants

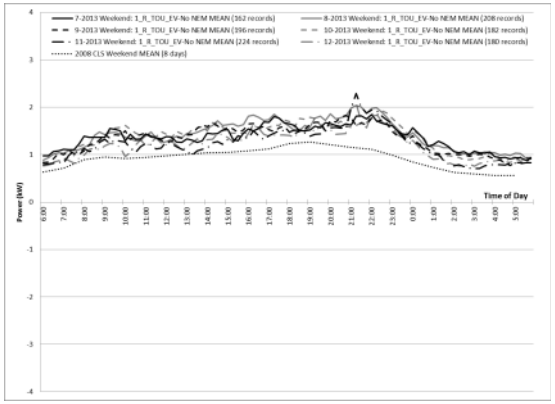
- Schedule TOU EV with NEM




- Schedule TOU EV without NEM



# Schedule EV-F

## Commercial Public EV Charging Facility Pilot

- Pilot rate through June 2018 to support the development of commercial public charging facilities with high demand (kW) charging.
- Separately metered, commercial rate for on-road EV charging facilities with a load no greater than 100 kW (5 kW ancillary load).
- Time-of-use rate, no demand charge.


Hawaiian Electric

# Schedule EV-F
## Commercial Public EV Charging Facility Pilot

- Enrollment
  - Hawaiian Electric 3
  - Maui Electric 2
- Avoided demand charge
  - Hawaiian Electric $11.69/kW
  - Maui Electric $10.00/kW

# Schedule EV-U
## Commercial Public EV Charging Pilot

- The Hawaiian Electric Companies may operate up to 25 public DC fast charging accounts across the combined service territories.
- Per session fee is tied to EV-U time-of-use rates.

# Fast Charger Deployment Lessons Learned

Property Managers Perspective

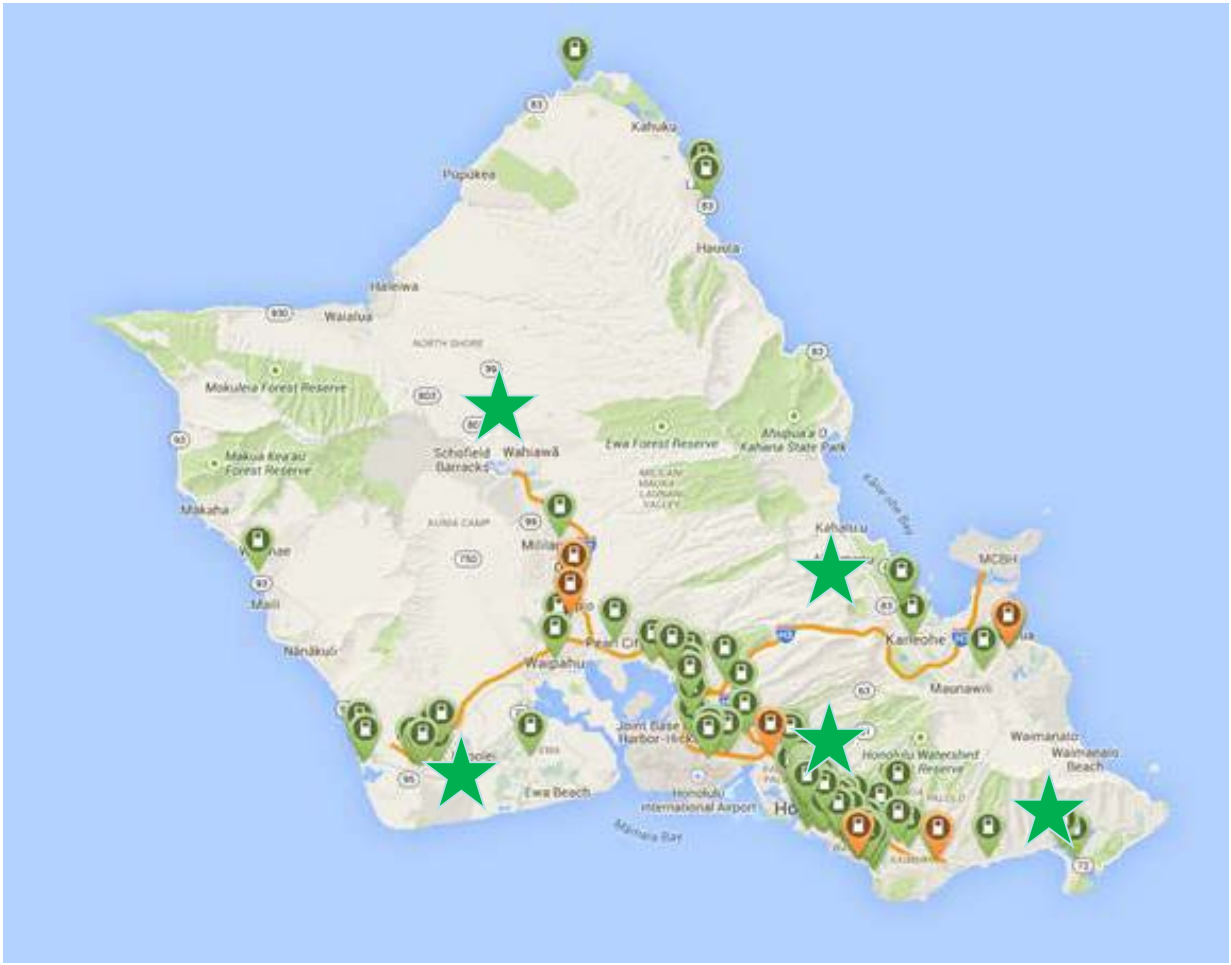
- Limited parking space – hesitant to give-up parking for FC
- 15 – 30 min. charging session needs to align with business model at location
- Value proposition

Miscellaneous

- Lengthy site and contract negotiations
- Availability of 3-Phase power can impact design/location complexity and cost
- Sourcing of leading-edge R&D FC – a challenge
  - Low volume
  - Evolving market/technical requirements

# Schedule EV-U

## DC Fast Charger Coming Soon


Hawaiian Electric

# opconnect®
## Electric Vehicle Charging System

**A Smarter, Cleaner, Greener Future™**

The OpConnect network manages hundreds of charging spots throughout the US

**OpConnect EV Charging Stations have…**

**Provided electricity to drive hundreds of thousands of miles**

**Avoided hundreds of metric tons of greenhouse gases**

**Saved thousands of gallons of gasoline**

# opconnect®
## Electric Vehicle Charging System

**A Smarter, Cleaner, Greener Future™**

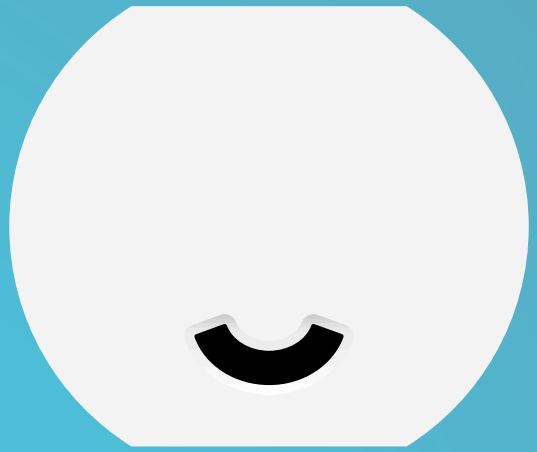
- 1500 members
- 150 charging ports
  - 42 workplace charging
  - 4 Multi-family
  - 106 public
- Most used sites
  - Ala Moana Mall
  - Topa Financial Center
  - Moanalua
  - U of H

# Our Challenges

- Multi-Family
  - Who pays costs
  - Assigned parking
- Costs of charging stations
  - Many states offer financial incentives
- Permitting time
- Installation costs

# 2015 and Beyond

- Continue to grow the network
- Transition to ad supported network
- Hawaii Energy pilot project
- Other demand response and smart grid projects



**Pilot Project Mission**

- Increase Daytime Charging of EVs as a means to utilize PV Capacity
- Education of the Energy Efficiency Offset options to balance EV Consumption

**Integration**

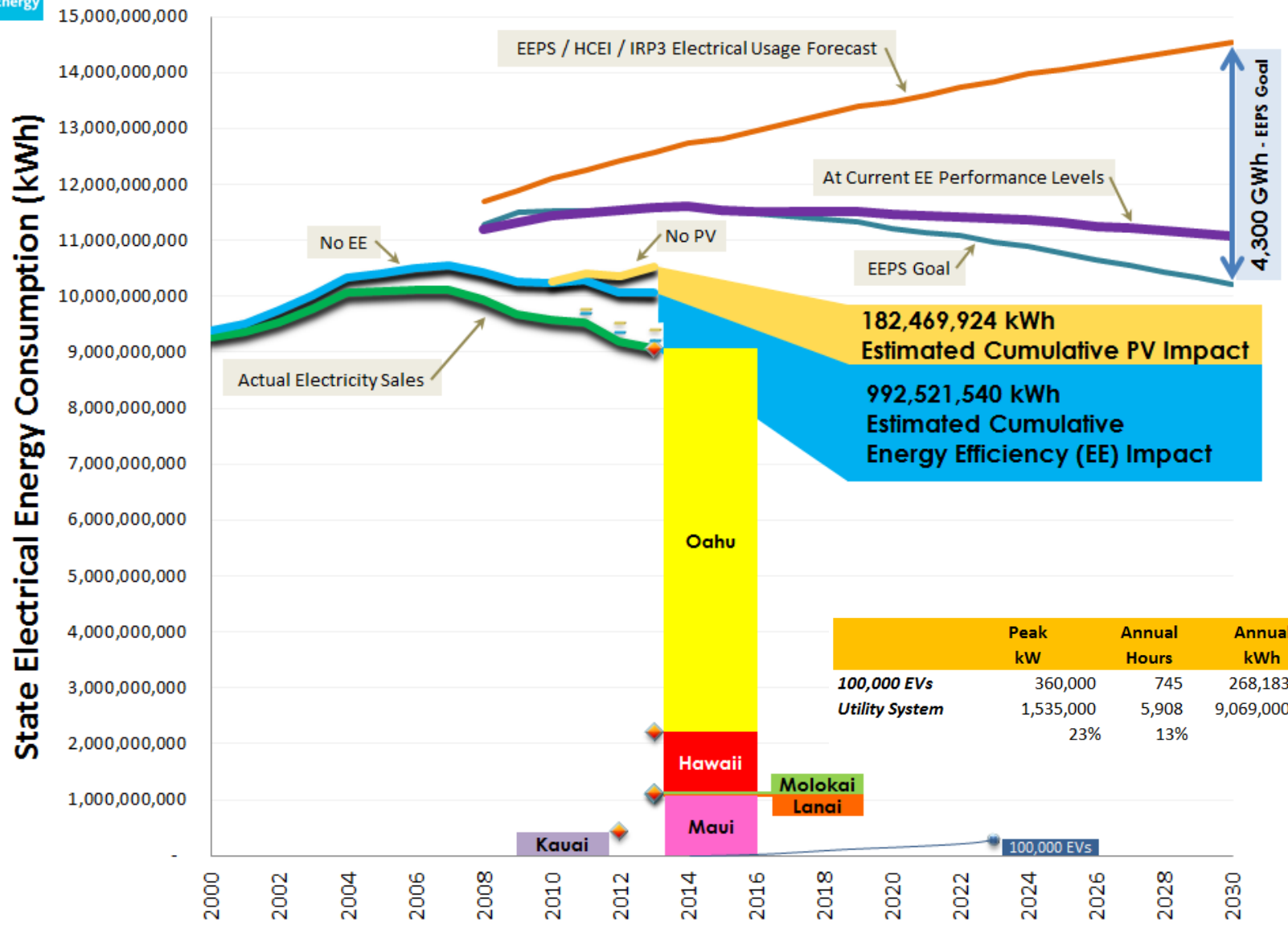
- Transformational Programs for Education and Outreach
- Commercial Building Energy Efficiency Actions
- Trade Ally Assistance

**Pilot Projects**

- Energy Savings Kits for EV Purchases
- EV Page Addition to Hawaii Energy Website
- EV Pricing Behavior Evaluation Pilot with Private EVSE

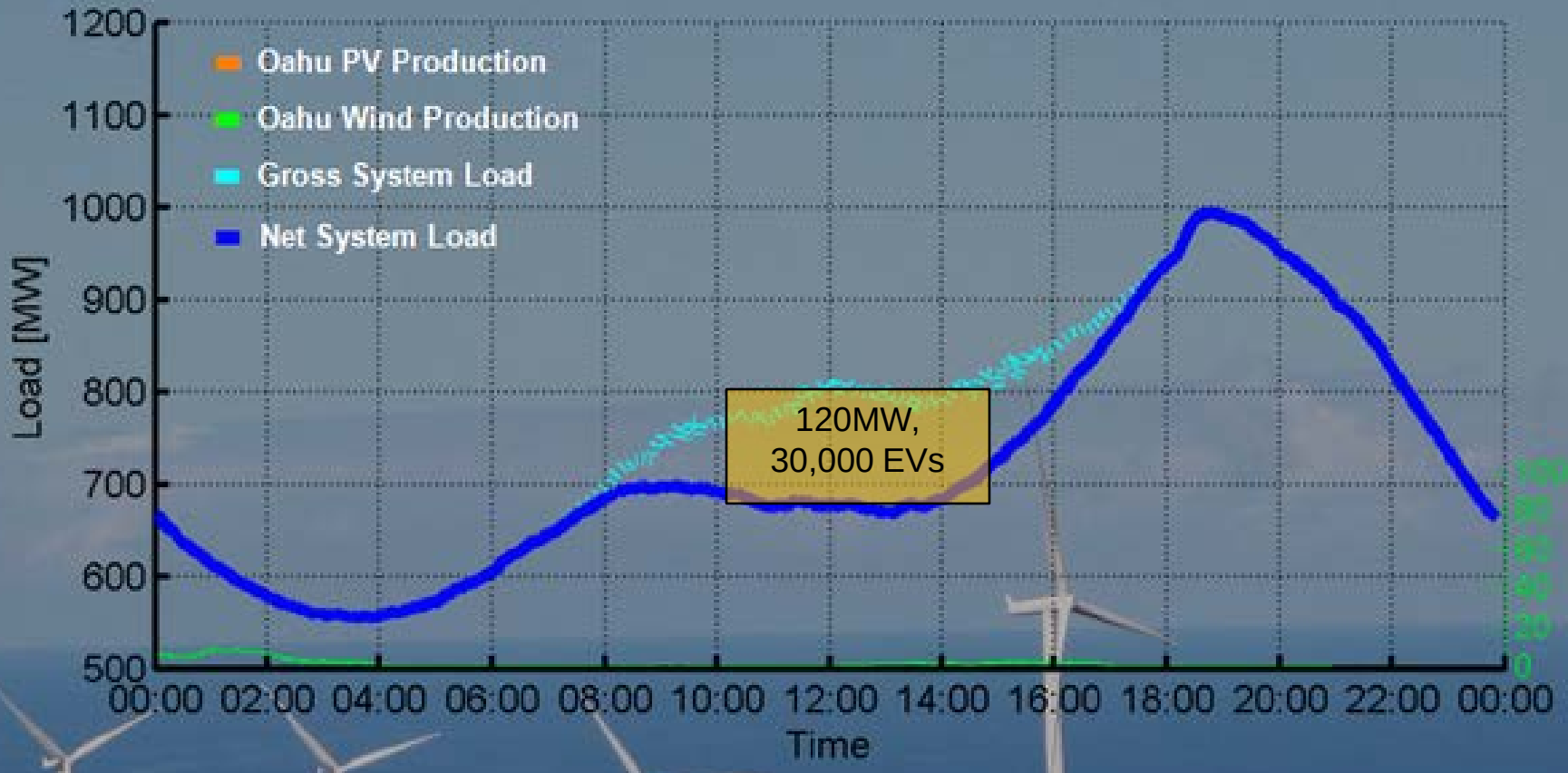
# BIG PICTURE

## Hawaii Energy - Electrical Energy Comparisons to EEPS Goal




| | Peak kW | Annual Hours | Annual kWh |
|---|---|---|---|
| *100,000 EVs* | 360,000 | 745 | 268,183,750 |
| *Utility System* | 1,535,000 | 5,908 | 9,069,000,000 |
| | 23% | 13% | 3% |

# Renewable Watch - Previous Day



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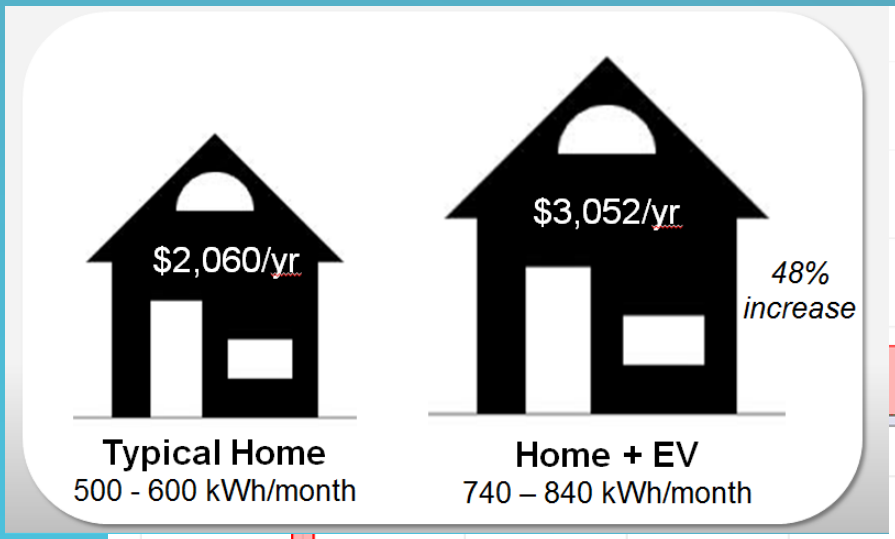
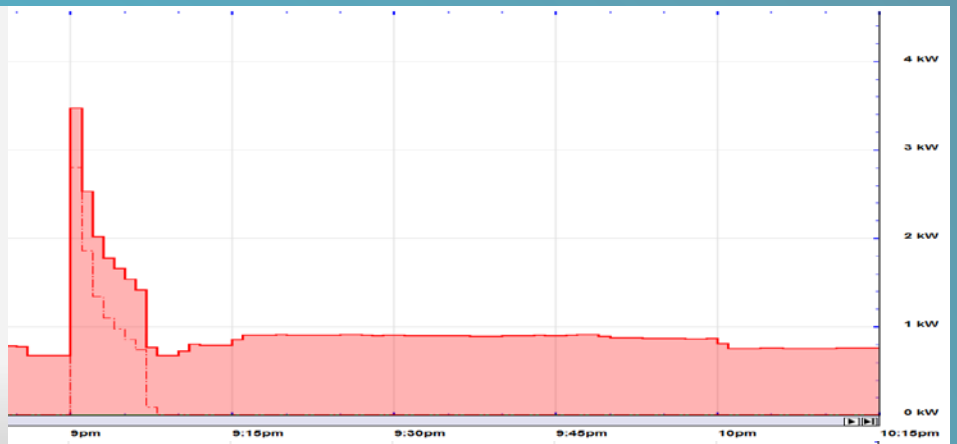
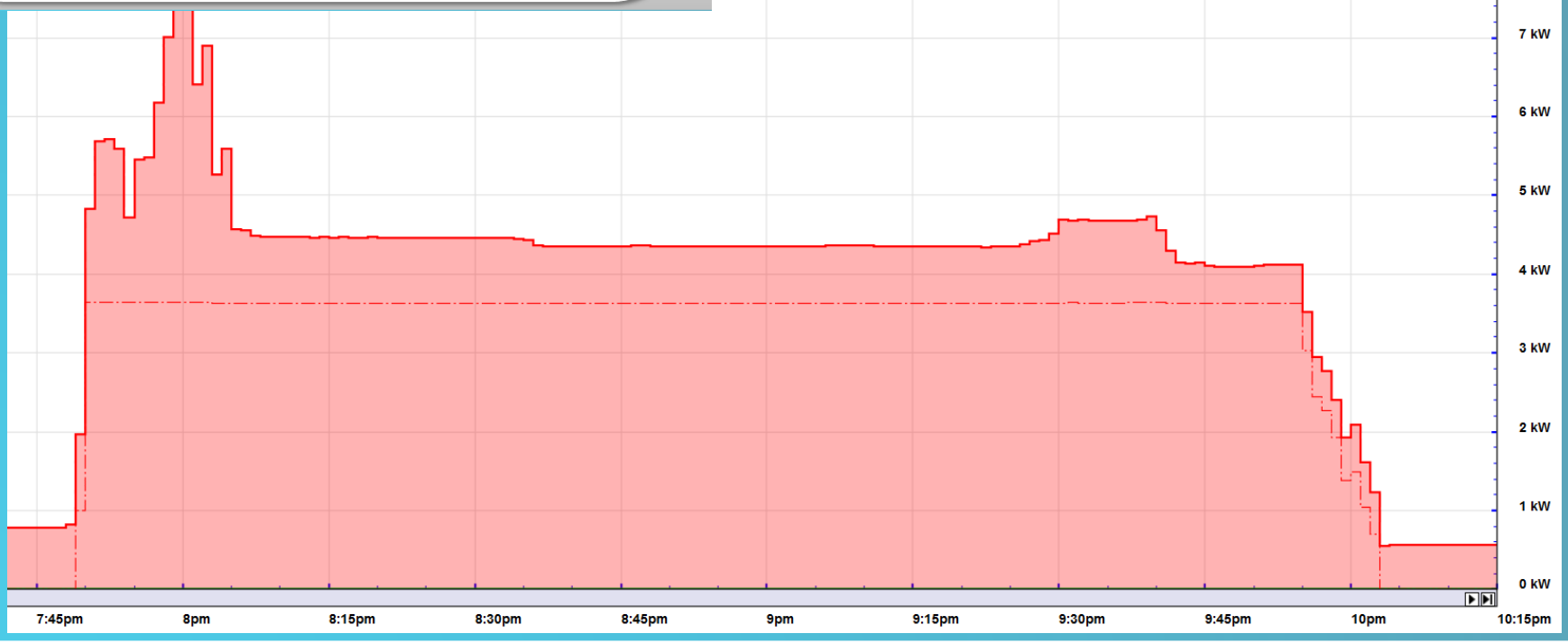

$2,060/yr
$3,052/yr
48% increase
Typical Home
500 - 600 kWh/month
Home + EV
740 – 840 kWh/month

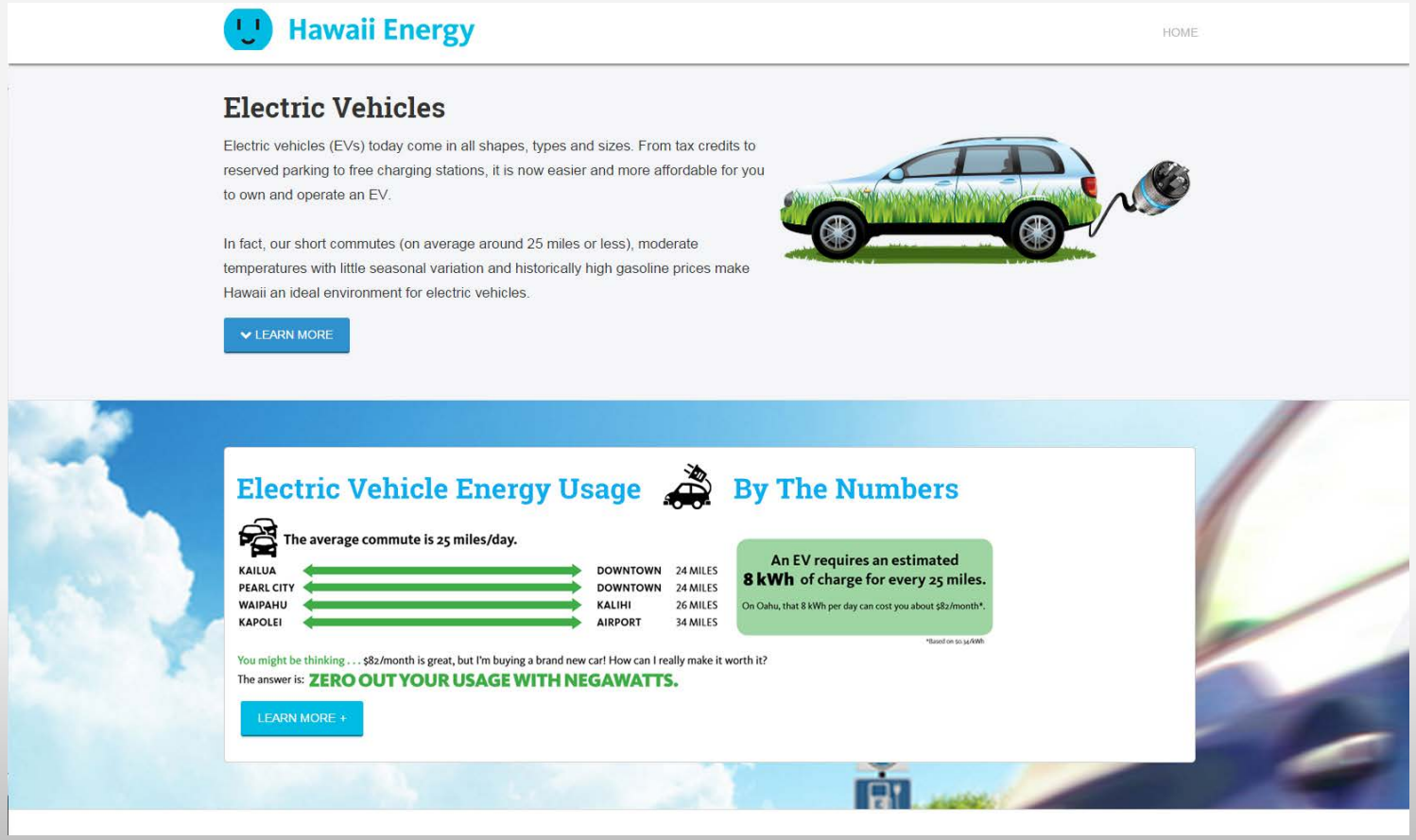

4 kW
3 kW
2 kW
1 kW
0 kW
9pm
9:15pm
9:30pm
9:45pm
10pm
10:15pm


8 kW
7 kW
6 kW
5 kW
4 kW
3 kW
2 kW
1 kW
0 kW
7:45pm
8pm
8:15pm
8:30pm
8:45pm
9pm
9:15pm
9:30pm
9:45pm
10pm
10:15pm

# What's inside?

**2** x LED ENERGY STAR lamps
**2** x Low-flow Water Sense faucet aerator
**1** x Low-flow Water Sense showerhead
**1** x Smart power strip

# EV Website


Hawaii Energy
HOME
Electric Vehicles
Electric vehicles (EVs) today come in all shapes, types and sizes. From tax credits to reserved parking to free charging stations, it is now easier and more affordable for you to own and operate an EV.
In fact, our short commutes (on average around 25 miles or less), moderate temperatures with little seasonal variation and historically high gasoline prices make Hawaii an ideal environment for electric vehicles.
LEARN MORE
Electric Vehicle Energy Usage
By The Numbers
The average commute is 25 miles/day.
KAILUA DOWNTOWN 24 MILES
PEARL CITY DOWNTOWN 24 MILES
WAIPAHU KALIHI 26 MILES
KAPOLEI AIRPORT 34 MILES
An EV requires an estimated 8 kWh of charge for every 25 miles.
On Oahu, that 8 kWh per day can cost you about $82/month*.
You might be thinking . . . $82/month is great, but I'm buying a brand new car! How can I really make it worth it?
The answer is: ZERO OUT YOUR USAGE WITH NEGAWATTS.
LEARN MORE +

# Mahalo!

**Stay Connected:**

Oahu: **1-808-537-5577** Neighbor Islands: **1-877-999-7242**

www.hawaiienergy.com

facebook.com/hawaiienergy @myhawaiienergy

Hawaii Center for Advanced Transportation Technologies

# HCATT

Brig. Gen. (ret.) Stan Osserman
Director

# HCATT – Agency Of State of Hawaii

Department of Business & Economic Development - Tourism

- Goals
  - Move Hawaii Towards Clean Trans. Energy
  - Lead as National Demonstration Center for Alternative Fuel Vehicles - JBPHH
  - Manage USAF H2 R&D Projects in Hawaii
  - Coordinate H2 Infrastructure Plans in Hawaii
  - Support Workforce Development and Job Creation for Hawaii (related to HiTech Trans)

# Move Hawaii Towards Clean Transportation Energy

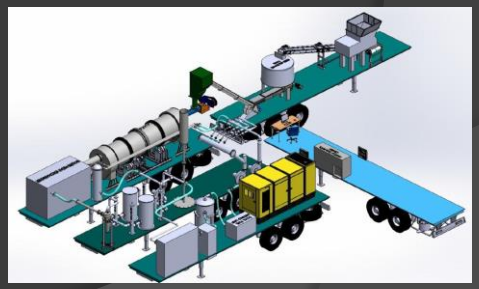
- Hawaii is highly dependent on Imported, carbon based, energy
- Oahu Residential Power is 37 cents per kWh and climbing, and the Neighbor Islands are even HIGHER
- Hawaii has abundant renewable energy
  - Solar, Wind, Geothermal, Ocean-thermal, Wave Motion, Hydroelectric…..
- The Military is leading energy consumer
- Security and Economics demand that we move Hawaii to energy independence

# National Demonstration Center for Alternative Fuel Vehicles - JBPHH

- Hawaii was designated ***The National Demonstration Center for Alternative Fuel Vehicles*** almost 20 years ago by DARPA
- HCATT has been the focal point for demonstrating Plug-in and Fuel Cell Electric Vehicles in Hawaii
- Transportation is our focus, but infrastructure and policy development are critical elements of a successful transportation strategy
- We engage our Congressional Delegation and Our State Legislature

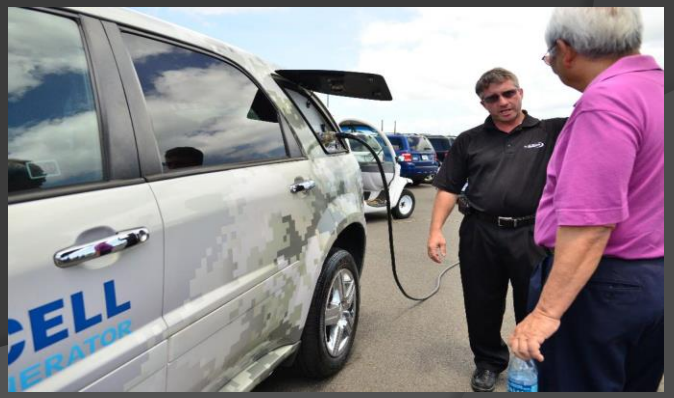
# Manage USAF H2 / R&D Projects in Hawaii

- HCATT currently manages 10 AFRL projects:
  - R-12 Re-fueler, Crew Bus, Dump Truck, Heavy Aircraft Tug, Weapons Loader, Secure Power Van, Hydrogen Production, Net-Zero F-22 Facility, 10 TPD W2E, Medium Wind



# Coordinate H2 Infrastructure Plans in Hawaii

- Hawaii Energy Office Strategic Plan
- Dept. of Energy Projects
  - Master Transportation H2 Plan
  - GSA H2 Feasibility Study
  - Young Brothers Stationary Fuel Cell
- PACOM W2E Joint Community of Interest
- Support Hawaii Natural Energy Institute
  - Volcano National Park Buses
  - Big Island MTA Shuttle



# Support Workforce Development and Job Creation for Hawaii (Related to High Tech Transportation)

- Support DBEDT efforts to create the future jobs and the training that prepare our workforce for High Tech Transportation Jobs
  - Safety Training
  - CC Curriculum Development
  - Promote business opportunities and encourage High Tech Transportation companies to set up shop in Hawaii


Hawaii can and should lead the way in developing clean transportation technologies for the World

After all, We've been doing it at HCATT for two decades!

# H2 Technology Status for HI

## H2 Fuel Cell and Battery EV Stakeholder Charrette
## January 13-14, 2015


**Rick Rocheleau**
**Mitch Ewan**
**Hawaii Natural Energy Institute**
**University of Hawaii at Manoa**


**15 September 2014**

HNEI
Hawai'i Natural Energy Institute
University of Hawai'i at Mānoa

# HNEI Fuel Cell/Hydrogen Research

- ***HI Sustainable Energy Research Facility (HISERF) (ONR, USDOE, HECO, NASA, Industry*)**
  - **Testing of fuel cell and battery systems for manned and unmanned vehicles**
  - **Development of advanced air filtration for FC operations in harsh environments.**

- ***Marine Corps Base Hawaii* Dual *Pressure "Fast-Fill" H2 Fueling Station (USDOE, ONR)***
  - **Basis for design of public stations**
  - **Unattended operation, 50 fills since Nov 2014**


- ***Hydrogen Energy Systems for Grid Management (USDOE, ONR, SOHI, Industry)***
  - **Demonstrate the use of electrolyzers to mitigate the impacts of intermittent renewable energy**
  - **Evaluate effect off multiple revenue streams on overall hydrogen costs.**

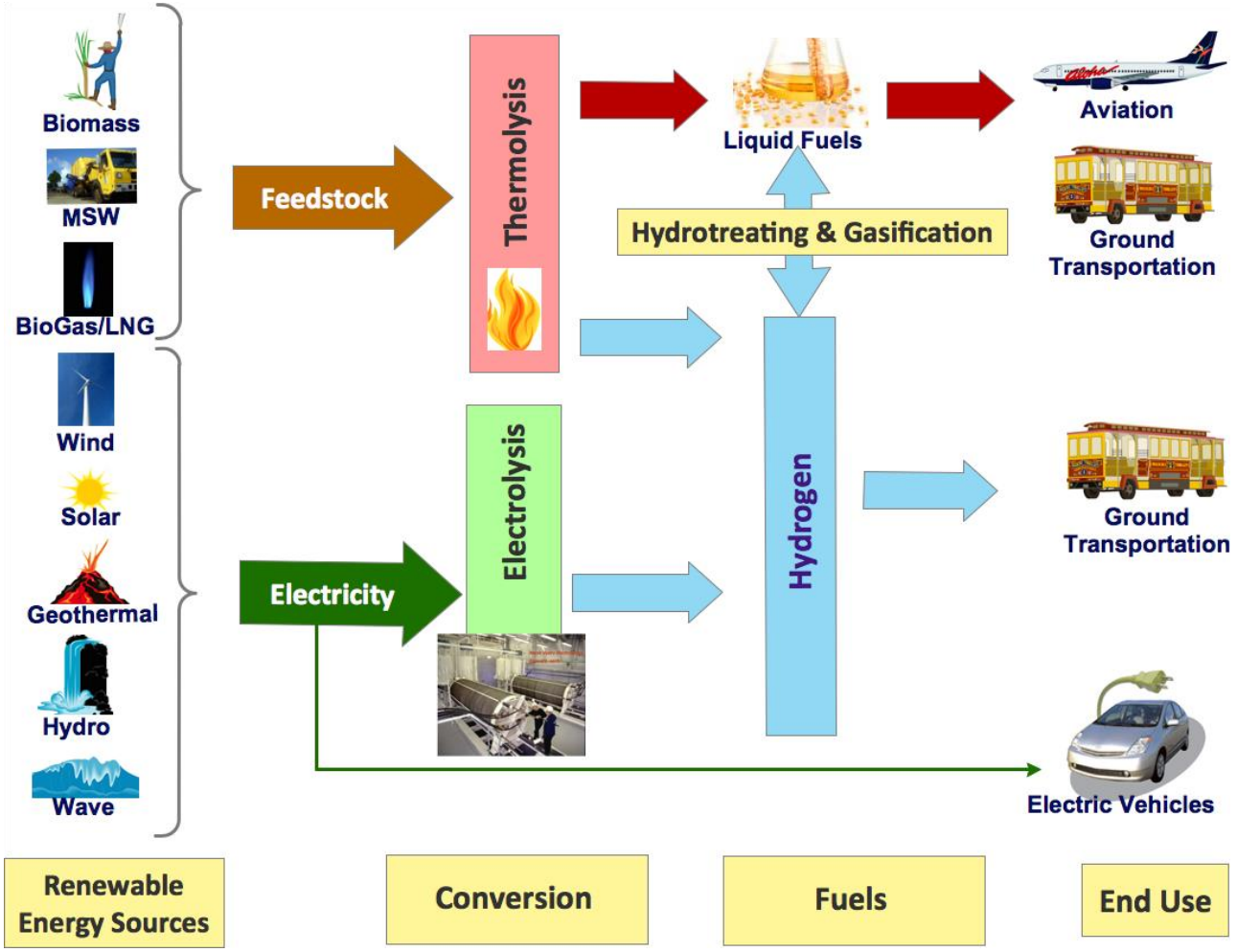
- ***Grid Analysis – Integration of renewables into HI grid systems***

# Hydrogen Energy Systems for Grid Management

**Demonstrate the use of electrolyzers to mitigate the impacts of intermittent renewable energy - evaluate potential to offset hydrogen costs by value added revenue streams.**

- **Grid models/grid scale battery experiments to determine duty cycle required to provide ancillary service to the grid**
- **Characterize performance/durability of commercially available electrolyzers under dynamic conditions able to provide ancillary services to grid, e.g. frequency regulation, spinning reserve**
- **Supply hydrogen to shuttle buses operated by County of Hawaii Mass Transit Agency, and Hawaii Volcanoes National Park;**
- **Conduct performance/cost analysis to identify benefits of integrated system including grid ancillary services & off-grid revenue streams**

# Renewable Fuels Pathways (simplified)




**HI Ground Transportation ~ 500 million gpy**

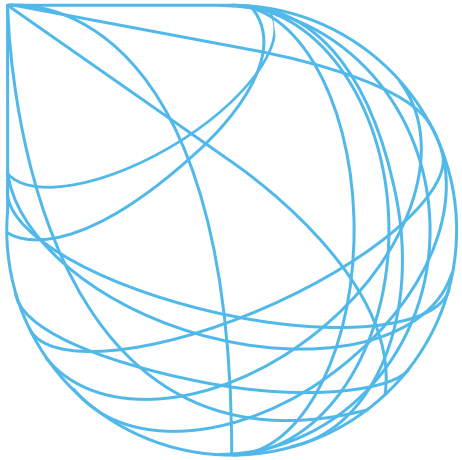
# Primary Resource for “20% Transportation” Hydrogen

- **Biomass to Hydrogen**
  - **Sustainable  growth at 20 dry tons per acre**
  - **Hydrogen yield, 70 kg/dry ton(NREL)**
- **Electricity to Hydrogen**
  - **36kw-hr/kg thermodynamic limit**
  - **~ 60% efficiency to compressed H2**
- **Assume H2-FC vehicles 2x efficiency of current vehicle fleet.**
- **Resource required to displace of 20% of current ground transportation fuel (100 Mil gal liquid fuel ~~ 50 mil kg H2)**
  - **35,000 acres “good” agricultural land (dedicated HC&S)**
  - **3000 GW-hrs/yr (~ 30% of current state electrical generation)**

**Scale of need requires portfolio of solutions**

# Summary

- **Industry making great strides with FC vehicles – industry will lead**
- **Continued demonstration valuable to validate performance and cost of infrastructure to distribute and dispense hydrogen**
  - **State can effectively support limited fueling infrastructure for fleet (public) demonstration**
  - **Address/develop codes and standards**
  - **Inform legal and insurance industry**
- **Demonstration useful to validate performance of production technologies but limited value unless coupled to long-term economic plan for large scale production**
  - **Competing use of limited resource – biomass, renewable electricity**
  - **Energy infrastructure is very capital intensive**
  - **Commercial scale requires substantial private investment**



# Big Island Hydrogen

H2 Transportation Fueling Infrastructure

Paul Ponthieux

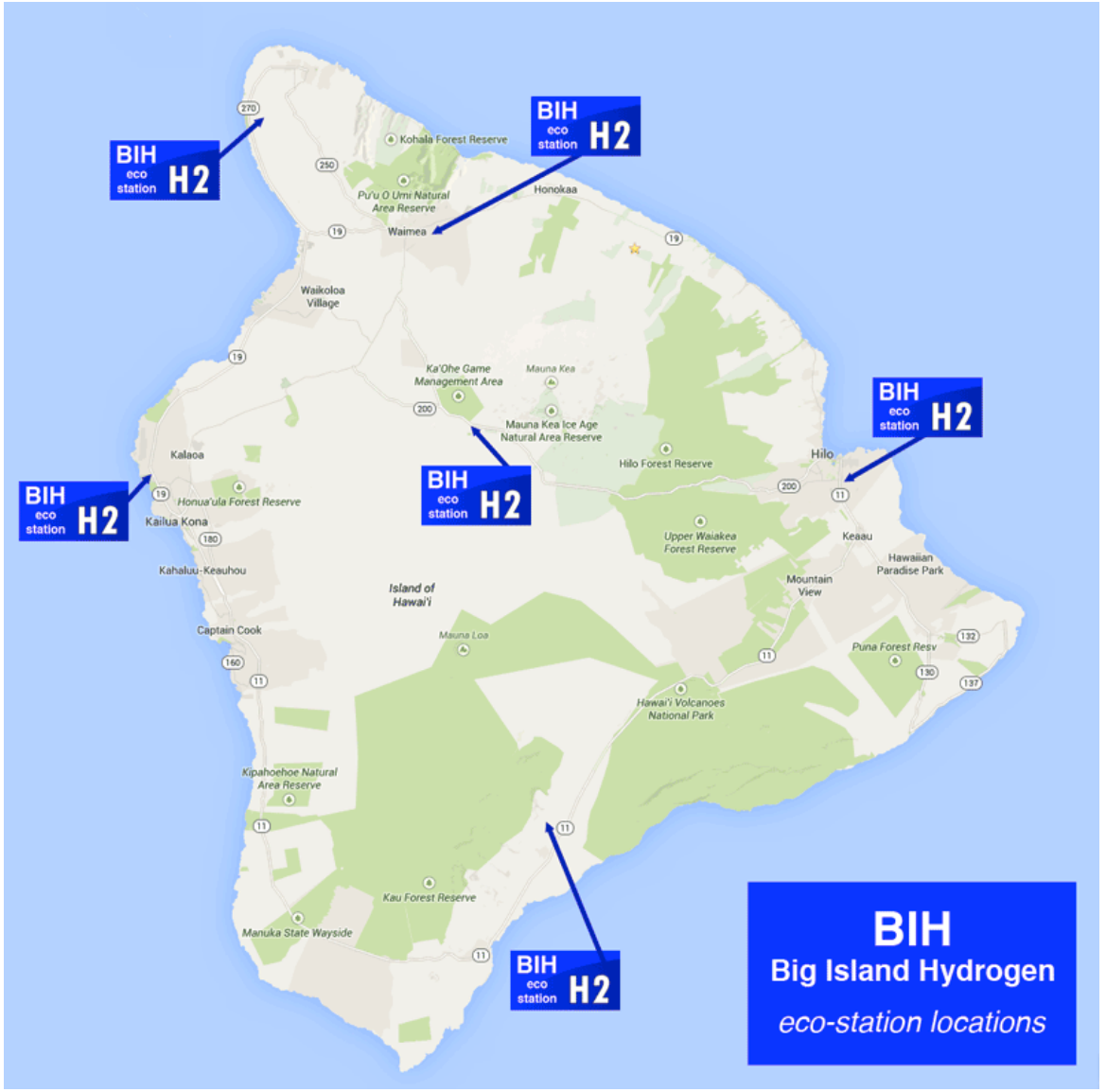
paul@blueplanetresearch.us

# Business Model

- Major Population Centers approx. 50 miles apart
- 5 Stations for Complete Mobility on Hawaii Island
- Low Cost of Entry Stations to scale as demand grows
- Utilize Low Cost Renewable Energy
- Initial targeting of Diesel Fleet Vehicles

# Locations

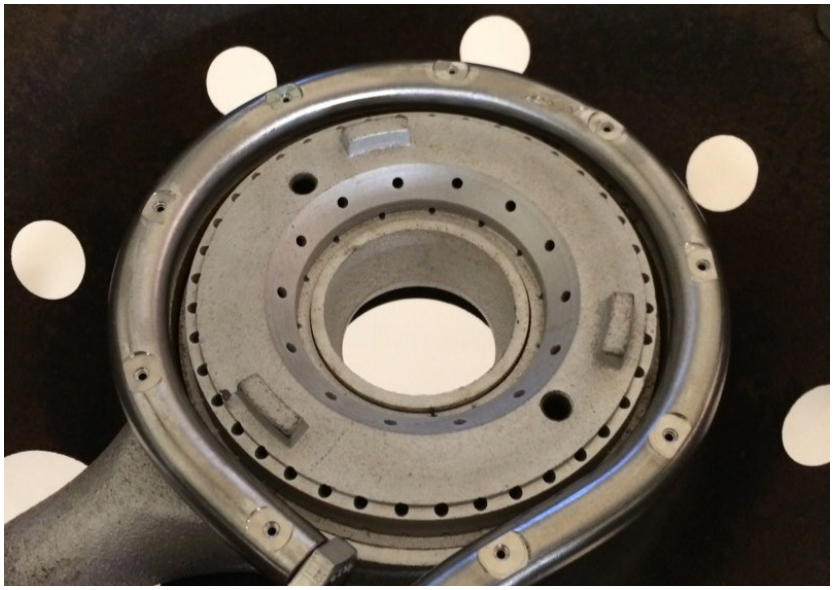
- Kona - (NELHA)
- Waimea Nui
- Hawi
- Saddle Road - (PTA)
- Hilo
- Ka’u



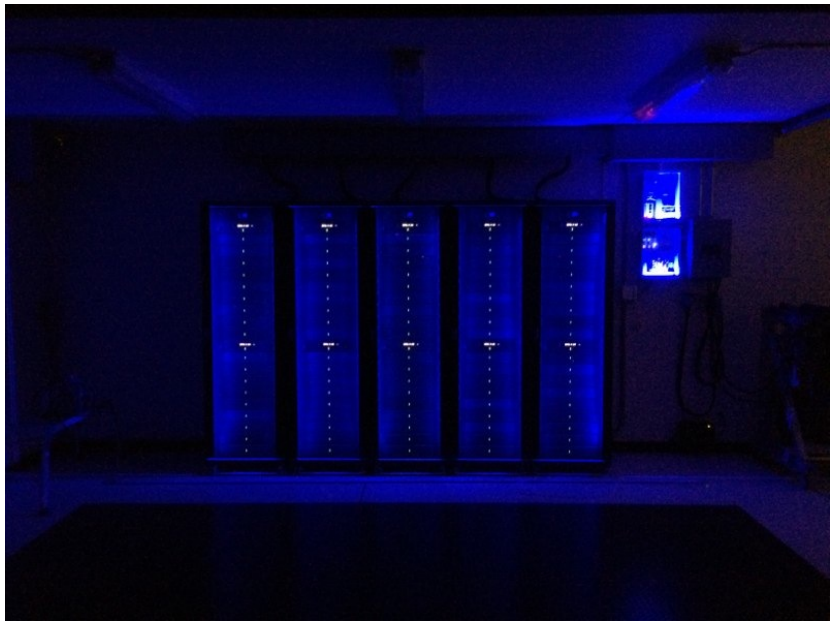
Alkaline Electrolyzer


H2 Fuel Cell Forklift

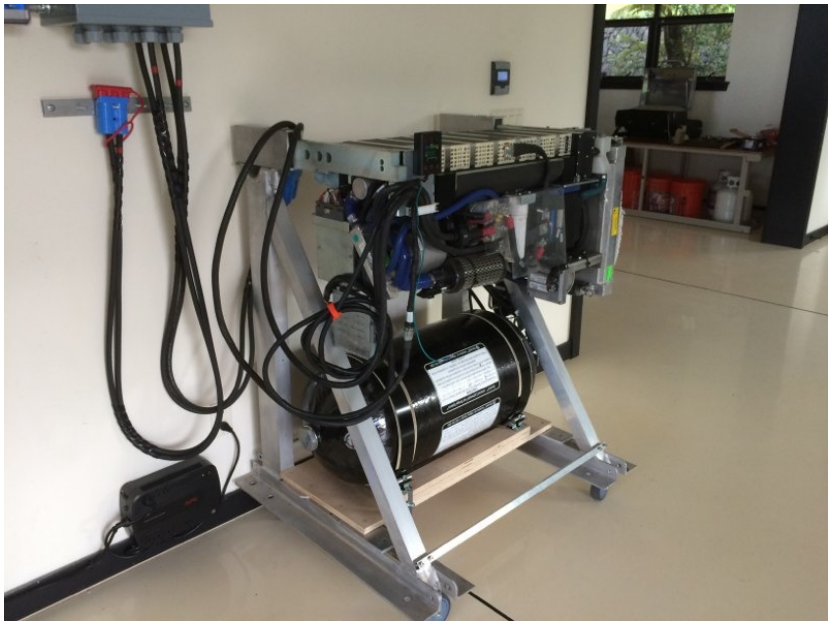
Low Pressure Storage



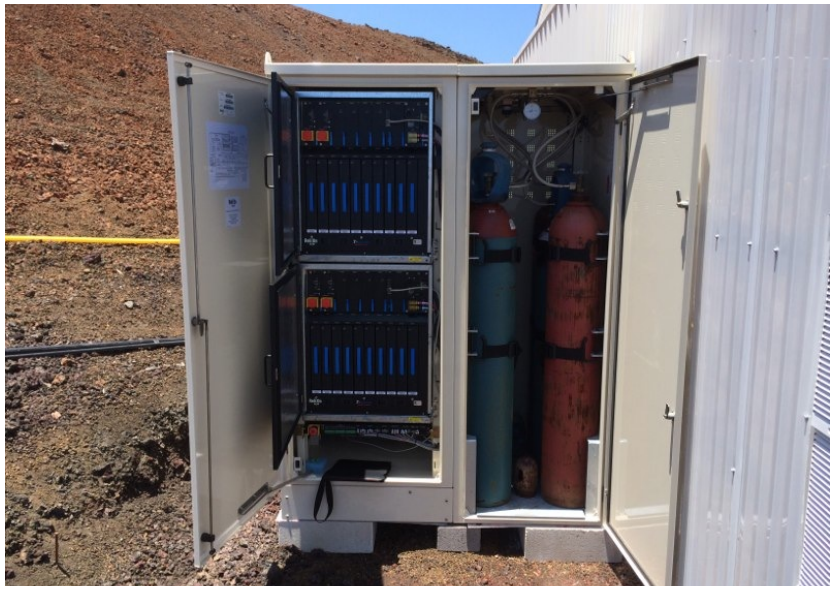
Hydrogen Burner Conversion



Off-Grid Storage Backup

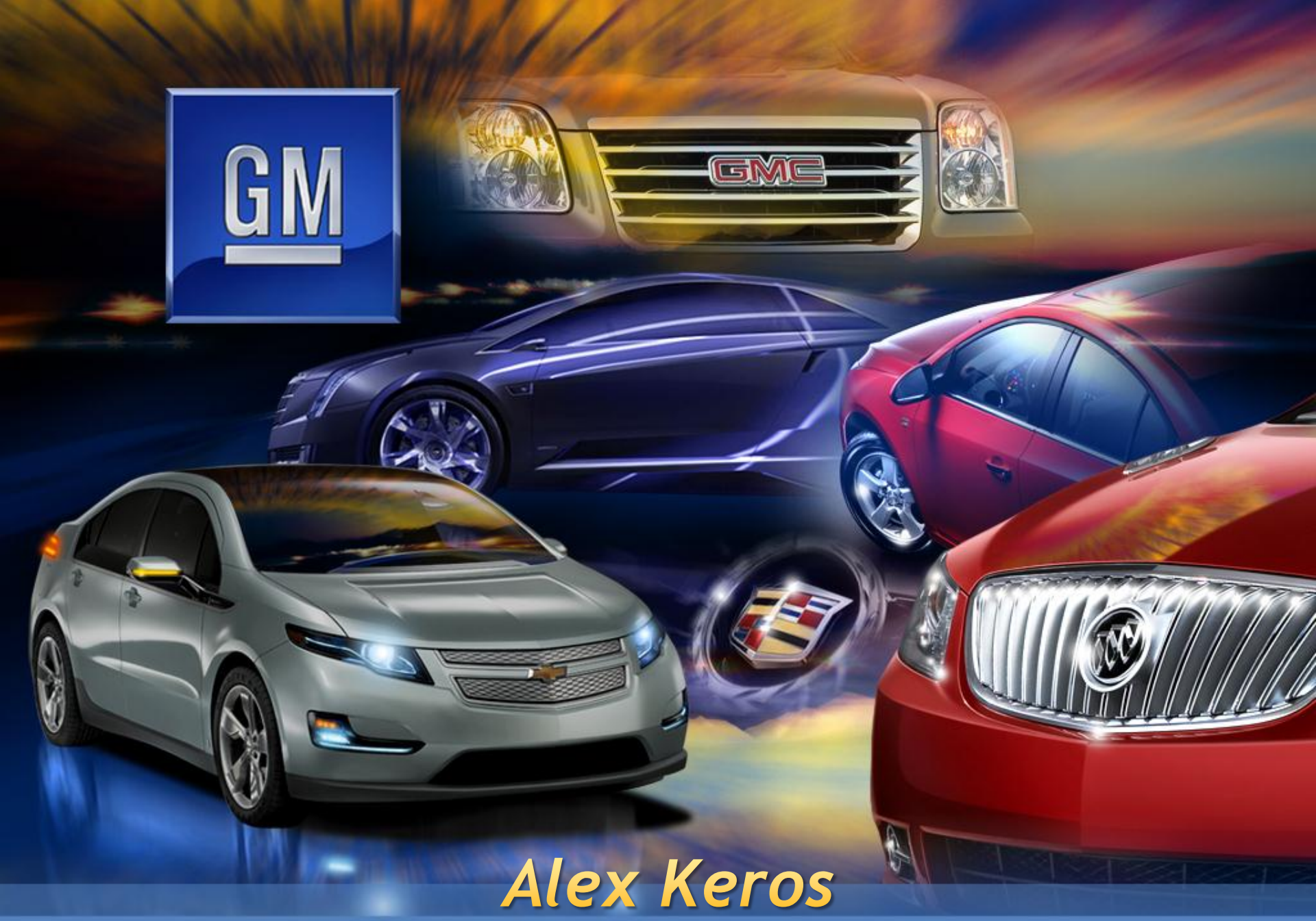


Repurposed H2 Forklift Fuel Cell



Mars Habitat Stationary Fuel Cell

HISEAS Test Project




# Alex Keros

## Manager, Advanced Vehicle & Infrastructure Policy

# Charles (Boss) Kettering

My interest is in the future….  Because I’m going to spend the rest of my life there.

# Transitioning from Internal Combustion to Electrified Propulsion

**Petroleum and Biofuels**
(Conventional and Alternative Sources)

**Electricity and Hydrogen**
(Zero Emissions Energy Sources)

| eAssist | Full Hybrid (2-4 mode) | Plug-in Hybrid | Extended Range Electric | Battery Electric | Fuel Cell Electric |
|---|---|---|---|---|---|

**Increasingly Electrified Powertrains**

- **Solutions needed for a full range of vehicles that provide customer choice.**
- **Battery and Fuel Cell vehicles provide petroleum/emissions-free options.**
- **Only Fuel Cell vehicles provide affordable 300+-mile range, quick refill.**

| *Approximate Recharge Times (miles/min)* | | | | |
|---|---|---|---|---|
| Gasoline | Electric | | | Hydrogen |
| | 15 kW | 50 kW | 1MW | |
| ***150*** | ***1*** | ***4*** | ***70*** | ***100*** |

# GM's Project Driveway | Real World Experience

119 vehicles in the hands of customers


6,500
EVERYDAY DRIVERS


~35,000 refueling events
> 75,000 kg of $H_2$ consumed

> 3,000,000 miles

2014: First vehicles to 125,000 miles

7 Winters: Including 18,000 Freeze Starts

# GM Fuel Cell | Collaborations & Announcements

## GM, Honda to Collaborate on Next-Generation Fuel Cell Technologies

Goal is commercially feasible fuel cell and hydrogen storage in 2020 time frame

*2013-07-02*


## GM and U.S. Army to Expand Fuel Cell Testing

New agreement enables continued development of technology

*2013-09-30*

## GM Investing $200 Million to Expand Powertrain Engineering

Consolidation of four locations will help speed advanced propulsion development

*2013-01-30*

## NREL and General Motors Announce R&D Partnership to Reduce Cost of Automotive Fuel Cells

**June 25, 2014**

# General Motors | Hawaii Initiatives

## Military Unveils Fleet of GM Fuel Cell Vehicles in Hawaii

Army, Navy and Air Force to evaluate real-world use

*2012-02-23*

- In **February 2012**, the Army, Navy, and Air Force unveiled fleet of 16 GM' hydrogen-powered fuel cell vehicles.
- The Army also has a vehicle which can be driven as well as act as a 25 kW mobile generator.
- GM operates a Fuel Cell Vehicle Service Center in Honolulu in conjunction with Hawaii Gas.
- GM continues to work closely with stakeholders on the development and installation of fueling infrastructure.


GM has also remained active with stakeholders exploring projects related to grid-integrated fuel cells (tri-generation), as well as fuel cell bus and fuel cell fork-lift opportunities.

# FCEV Readiness | Enabling an Early Market

## *Technology Development*

*Fuel cell System Platinum Reduction*

*Hydrogen Tank Carbon Fiber*


## *Supply Base Development*

*Achieving economies of scale*

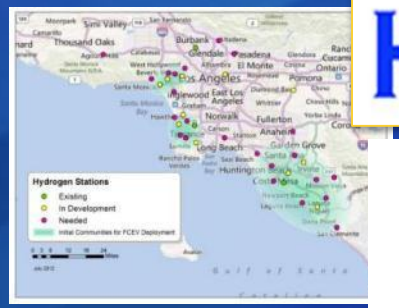
*Adopt common parts where possible*



## *Hydrogen Infrastructure*

*Regional Planning & Certainty*

*Deployment Execution*




$H_2$ USA

California FUEL CELL PARTNERSHIP

DRIVING FOR THE FUTURE


Back
Home
Fav
75°F
11:16 AM
Home Page
Now Playing
ECO
Phone
Climate Control
AM
FM
XM
CD
Last
1 of 2
AUTO
CLIMATE
TUNE MENU
TONE
BACK
CONFIG
SOURCE
SEEK
TP
FAV
SEEK
VOL
AS 1-2
INFO
DRIVE MODE


VOLT

# Chevrolet Volt Impact to Date*

**Volts sold through December 2014 ~73,000**


Chevrolet Volt Earns IIHS Top Safety Pick + Award

Only small car of 12 in recent testing to earn distinction

*2014-07-30*

**Gas is Optional**

On a full charge, Volt can get an EPA-estimated 38 miles gas-free, and Volt owners who charge regularly average 900 miles between fill-ups.

Source: www.chevrolet.com/volt-electric-car.html running ticker on January 8, 2015

* Only Includes Opted-in vehicles

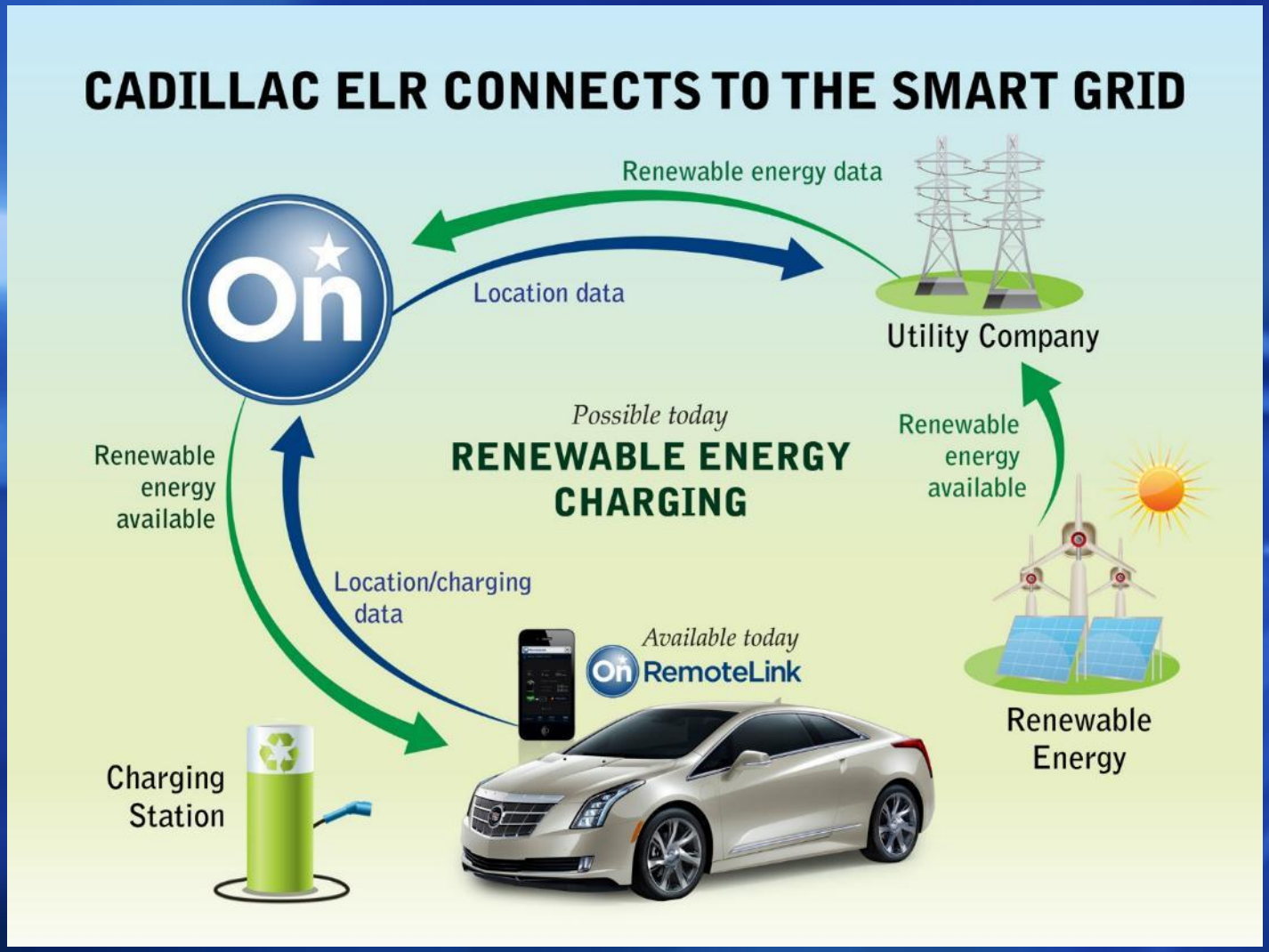
# Introducing...


...2016 Volt

# And…

…Chevrolet Bolt Concept

# Market Considerations | Grid Services




- Time of Use
- Renewables
- Aggregated Services
- Demand Response
- Ancillary Services
- Fleet Management
- API

**GM is very active in discussions with utilities (e.g. EPRI Collaboration) and utility commissions (e.g. CA, CO, MA) to ensure vehicle-grid integration benefits all utility customers**

# Market Considerations | Stakeholder Collaboration

California Fuel Cell Partnership — DRIVING FOR THE FUTURE

**A California Road Map: The Commercialization of Hydrogen Fuel Cell Vehicles**

The realization of fuel cell electric vehicles and supporting infrastructure requires a road map for investments in fuel cell electric vehicles and hydrogen fueling stations.

June, 2012

California Plug-In Electric Vehicle Collaborative

**Streamlining the Permitting and Inspection Process for Plug-In Electric Vehicle Home Charger Installations**

APPROVED

**Report and Recommendations, Version 2**
July 2012

Governor's Office of Planning and Research, State of California

The Great Seal of the State of California

**Zero-Emission Vehicles in California: COMMUNITY READINESS GUIDEBOOK**

Toward 1.5 Million Zero-Emission Vehicles on California Roadways by 2025

Published fall 2013. First Edition.

This Guidebook is intended to be an accessible informational resource that supports the expansion of zero-emission vehicles. It may be reproduced and distributed without permission. Please acknowledge this Guidebook as a source of information when using its content in other documents or presentations.

# PEV Readiness | Enabling an Early Market

## *Coordination and Cooperation*

***Task Force organized around key issues***

## *Simplify*

***Complexity is inherent with so many stakeholders***

***Strive for simplicity wherever possible relative to the consumer experience***

## *"Walk before you run"*

***Avoid burdening the system in the near term with long term considerations***

# Diverse Customer Needs

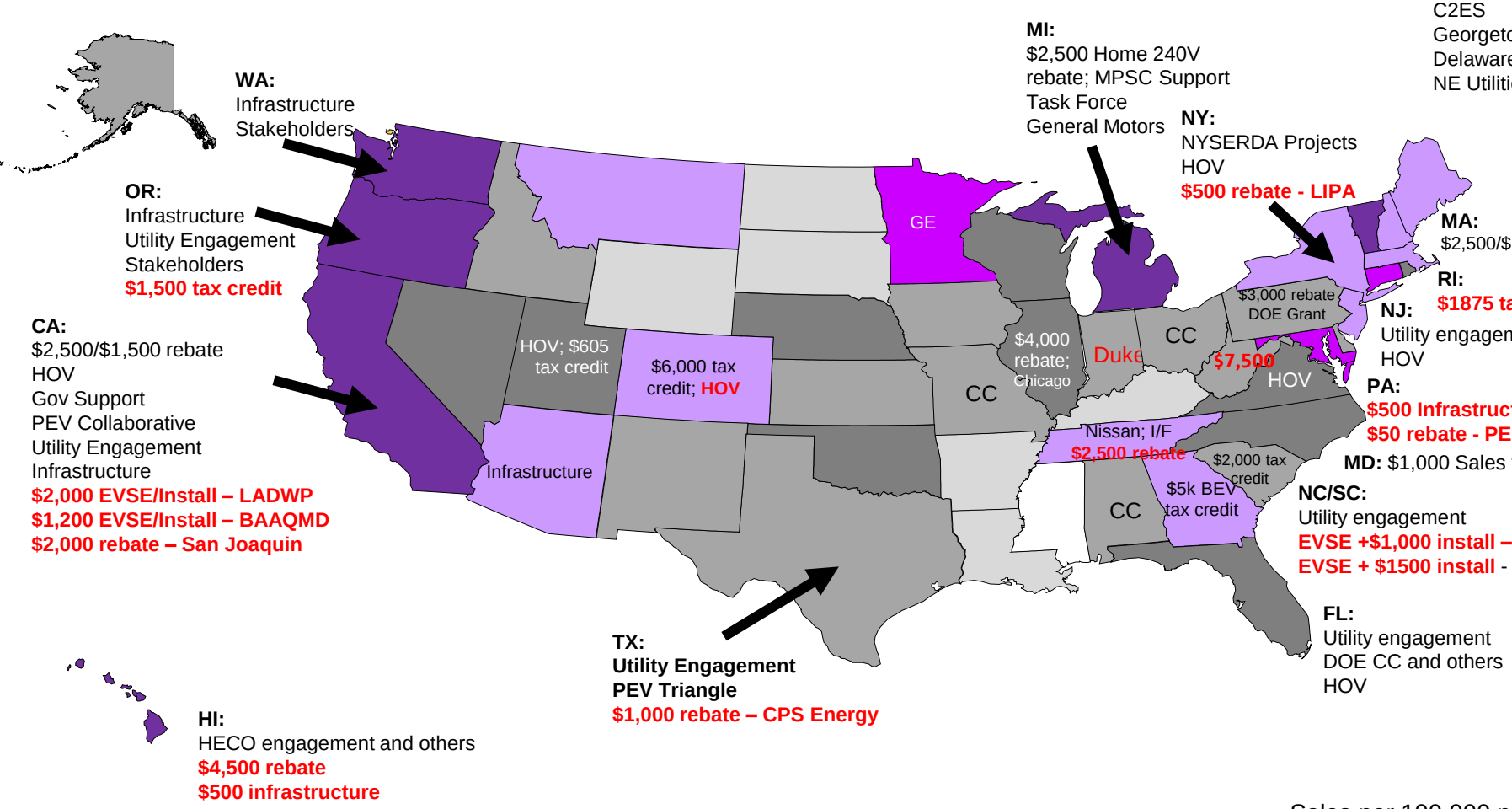
## Hydrogen Fuel Cell Chevrolet Equinox – at Work


**Customer Expectations: No Compromises**

# PEVS Sales| Per capita (BEVs, EREVs, PHEVs)

red = expired

Sales per 100,000 people – through August 2013




Sales per 100,000 people

- >50
- >40
- >30
- >20
- >10
- >5
- <5

**Together with complementary policies, there is good correlation between states with PEV sales and those states with strong stakeholder engagement efforts.**


SERVCO
FUELCELL

# Toyota's Vision

- Environmental Leadership
- Ultimate Eco-Car
- Long Term

# 2016 Toyota Mirai

# 2016 Toyota Mirai

- Over 20 Years of Hydrogen Fuel Cell development
- In-house development
- Extensive product testing
- 5,680 Global Patents

# Servco Automotive

- Community and Environment
- Vehicles
- Internal use fueling capability

# Resources

- http://servco.com/
- http://pressroom.toyota.com/